

CESAME

Centre for Systems Engineering and Applied Mechanics

ACTIVITY REPORT

1999

Bâtiment EULER
Avenue Georges Lemaître, 4
B-1348 Louvain-la-Neuve - Belgique
Tél. Sec. : +32 10 47 25 97 Fax : +32 10 47 21 80

Contents

1. Personnel	1
1 Academic staff	2
2 Academic and post-doctoral visitors	2
3 Temporary scientific staff	2
4 Administrative and technical staff	4
2. Research activities	5
1 Linear systems and control design	6
1.1 Tuning of PID controllers	6
1.2 Iterative controller tuning	6
1.3 Model and controller reduction	6
2 Model-free Predictive and LQG control	6
3 Nonlinear dynamics and control	7
3.1 Nonlinear control of positive and mass balance systems	7
3.2 Nonlinear control of discrete time systems	7
3.3 Nonlinear control : Low-gain design	7
3.4 Modelling and control of nonholonomic systems	7
4 System Identification	8
4.1 Identification and validation for robust control design	8
4.2 Identification of nonlinear systems	8
5 Fuzzy control	9
5.1 Fuzzy predictive control	9
5.2 Passivity approach	9
6 Analysis and control of infinite-dimensional systems	9
7 Biomedical engineering.	10
7.1 Gaze orientation	10
7.2 Analysis of pathological human gait	11
8 Multicriteria decision support tools with applications to sustainable development issues	11
9 Applications of modeling, identification and control	11
9.1 Electrical, mechanical and electromechanical systems	11
9.2 Fault detection and isolation for gas turbine engines	11
9.3 Modelling and control of biotechnological systems	12
9.4 Control of chemical processes	12
9.5 Modelling and control of industrial Grinding Processes	12
9.6 Control of Hydraulic Systems	12

10 Numerical methods in systems and control	13
10.1 Structured matrix problems	13
10.2 Distance and robustness problems	13
10.3 Large-scale dynamical systems	13
10.4 Orthogonal transformations and functions	14
10.5 Software development	14
11 Complexity of dynamical systems and control design	15
12 Micro-Macro Approach in Computational Rheology	15
13 Crystal growth	15
14 Injection moulding	16
15 Deformation, damage and fracture of engineering materials	16
16 Micro-tip forming	16
17 Lagrangian simulation of bluff-body flows	17
18 Large Eddy Simulation (LES) of turbulent flows	17
19 Lagrangian simulation of shear flows with combustion	18
3. Publications	19
4. Teaching activities	29
1 Undergraduate and Graduate Teaching	30
1.1 Applied Mathematics	30
1.2 Mechanics	31
1.3 Systems and Control	33
1.4 Other	35
2 Post-Graduate Training	35
2.1 The Graduate School in Systems and Control	35
2.2 Graduate course on Numerical Methods for Systems and Control	36
2.3 The Graduate School in Computational Mechanics (GRASCOM)	36
2.4 Graduate course on Developing countries, demography and environmental issues	37
2.5 Graduate course on Sustainable management and technology	37
2.6 Graduate course on European CLUSTER Postgraduate Programme on Environmental Technologies and Engineering” (CLUSTER consortium of European universities : EPFLausanne, PoliTorino, UCL/FSA, TUDarmstadt)	37
2.7 Continuous education	37
3 Other teaching activities	38
5. Seminars at CESAME	39
6. National or international contacts	43
1 Visits received	44
2 Scientific missions	46

7. Research funding	57
1 Federal Office for Scientific, Technical and Cultural Affairs	58
2 European Programmes	58
3 Regional Programmes	61
4 Special Research Fund (UCL)	61
5 Industrial Contracts	62
6 Other international contracts	64
8. Scientific awards and responsibilities	65

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
INSTALLÉ 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 M.Elarbi	01/01/99 - 31/01/99	Visiting professor
	18/08/99 - 18/09/99	
BERIS A.N.	16/08/99 - 31/12/99	Visiting professor
KLAN Pietr	01/01/99 - 15/07/99	Postdoctoral researcher
ORLOV Louri	01/09/99 - 31/10/99	Postdoctoral researcher
PENGOV Marco	01/01/99 - 31/08/99	Postdoctoral researcher

3 Temporary scientific staff

ANSAY Pierre (External member)
AVOWLANOU Kokou 15/09/99 - 31/12/99
BENAYAD Mohammed 01/01/99 - 30/08/99
BLOHM Gunnar 01/11/99 - 31/12/99
BOMBOIS Xavier
BURKHART Stéphane
CHAHLAOUI Younes 01/10/99 - 31/12/99
CHEN Libei
CODRONS Benoît
COIMBRA Alexandre

DAUTREBANDE Nathalie	01/01/99 - 30/09/99
DAVID Benoît	
de BROUWER Sophie	
DELATTRE Cédric	01/10/99 - 31/12/99
GALLEZ Xavier	
GIANOLI Lorenzo	01/01/99 - 31/08/99
GOMEZ Guillermo	
GROGNARD Frédéric	
GROSSO Massimiliano	01/01/99 - 31/10/99
HADJILI Mohamed	
HADJ-SADOK Zakaria	01/09/99 - 31/10/99
HENRY Philippe	01/01/99 - 30/06/99
HALIN Pierre	01/01/99 - 30/09/99
JEANMART Hervé	
JEGGY Cécile	
LAABISSI Mohamed	01/06/99 - 31/07/99
LECOMTE Christophe	01/01/99 - 30/06/99
LEFEVRE Laurent	
LEGRAND Sébastien	01/10/99 - 31/12/99
LENDASSE Amaury	
LEYGUE Adrien	01/09/99 - 31/12/99
LIELENS Gregory	01/01/99 - 31/10/99
LOIX Fabrice	01/10/99 - 31/12/99
MAGOTTE Olivier	
MOENS Luc	
MOHYMONT Bernard	01/10/99 - 31/12/99
MOTTE Isabelle	
MUNHOVEN Serge	01/01/99 - 30/11/99
NICHITIU Codrin	
NIKOLOV Svetoslav	
OUAAR Amine	20/09/99 - 31/12/99
PARRINI Simone	
PLOUMHANS Paul	
REGNIER Vincent	
ROLINSKY Roman	23/03/99 - 31/12/99
STANCIULESCU Cristina	
STEFAN Radu	15/02/99 - 31/12/99
THIRIFAY François	
WAPPEROM Peter	
WU Liang	01/09/99 - 31/12/99
ZEALOUK Lahbib	01/01/99 - 30/09/99

4 Administrative and technical staff

DE BOECK Lydia	Secretary (half-time)	
DECKER Christelle	Administrative Assistant (half-time)	01/08/99 - 31/12/99
DE RUYVER Michel	Technician (half-time)	
DE WAN Michel	Technician	
DONDERS Guido	Computer analyst	
HISSETTE Isabelle	Secretary (half-time)	
HUENS Etienne	Computer scientist	01/06/99 - 31/12/99
LAMISSE Laurence	Administrative Assistant (half-time)	01/01/99 - 14/06/99
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 3 of this report.

1 Linear systems and control design

1.1 Tuning of PID controllers

(R. Gorez)

This research on PID control was initiated during a SSTC fellowship given to Dr. G. Calcev, and it was pursued in the frame of a Copernicus project funded by the European Commission. Our expertise in the field was acknowledged by an invitation to give the opening conference in a study day organized by the Belgisch Instituut voor Regeling en Automatisatie in Antwerpen, March 1999. Three papers are accepted for publication in the European Journal of Control, in AUTOMA (Czech Journal of Control - *Reference 2000.40*), and in the British Journal Measurement+Control (*Reference 2000.48*). Another paper is accepted for presentation in PID'00 (IFAC Workshop on Digital Control : Past, present and future of PID control), Terrassa, Spain, April 2000 (*Reference 99.55*).

Keyword : Control

References : 99.15, 99.55

1.2 Iterative controller tuning

(O. Lequin, M. Gevers, L. Trieste)

A method has been developed for the iterative tuning of controllers (e.g. PID controllers) in view of minimizing the settling time of the closed loop step response. The method is based on the Iterative Feedback Tuning (IFT) scheme developed at CESAME in 1994. In 1997, O. Lequin had suggested the idea of applying zero weighting on the tracking error term in the IFT criterion during the time interval of the transient of the closed loop step response. The new development expands on this idea: the zero weighting interval is chosen large initially and then successively reduced until an overshoot occurs. This has the effect of minimizing the settling time.

Keyword : Control

Reference : 98.53

1.3 Model and controller reduction

(B. Codrons, P. Bendotti, C.-M. Falinower, M. Gevers)

In this work, funded by Electricité de France (EDF), we have used a high order model of the secondary circuit of a nuclear Pressurized Water Reactor (PWR) as a benchmark to compare different ways of designing a low order controller for a high order system. In this application, the EDF model, viewed here as the “true system”, is of order 42. Following up on our earlier work in which closed loop identification for control methods were used for the design of a low order controller, we have here compared model reduction and controller reduction methods. The conclusion of our study is that the key factor to success is to use closed-loop rather than open-loop reduction techniques. In addition, controller reduction gave better results than model reduction followed by model-based controller design.

Keyword : Control

References : 99.54

2 Model-free Predictive and LQG control

(W. Favoreel, B. De Moor, P. Van Overschee, M. Gevers)

Some interesting similarities between predictive control formulas used in Generalized Predictive Control (GPC) and formulas that occur in subspace identification have led us to derive a method for the calculation of both GPC and Linear Quadratic Gaussian (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 : Control

References : 98.70, 98.92, 99.85

3 Nonlinear dynamics and control

3.1 Nonlinear control of positive and mass balance systems

(N. Dautrebande, G. Bastin)

A general state space description of the modelling of engineering systems that are governed by a law of mass conservation has been developed. These models satisfy physical constraints of positivity and mass conservation. These conditions have strong structural implications that lead to particular Hamiltonian and compartmental representations.

In general, mass balance systems have multiple equilibria, one of them being the operating points of interest which is locally asymptotically stable. However if big enough disturbances occur, the process may be lead by accident to a behaviour which is undesirable. The control challenge is then to design a feedback controller which are able to prevent the process from such undesirable behaviours. A positive control law for the feedback stabilisation of a class of positive mass balance systems which are dissipative but can nevertheless be globally unstable has been developed. Lyapunov control design for food-chain systems using Lotka-Volterra Lyapunov functions has also been investigated.

References : 98.54, 98.85, 99.4, 99.16

3.2 Nonlinear control of discrete time systems

(D. Nesic and G. Bastin)

Stabilizability and dead-beat control design for Wiener-Hammerstein models have been investigated. It has been proved that a generic condition is sufficient for a null-controlable system to have a stabilizing minimum-time controller. When this condition is violated, it has also been shown how to design a nonminimum time stabilizing dynamic dead beat controller. These results are used to obtain general stabilizability conditions for Wiener-Hammerstein systems.

References : 95.07, 97.85

3.3 Nonlinear control : Low-gain design

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

The global stabilization has been achieved by a low-gain saturated feedback for a class of feedforward systems having an unstable Jacobian linearization. The control law forces the derivative of the state variables to small values along the closed loop trajectories.

References : 98.119

3.4 Modelling and control of nonholonomic systems

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

We develop, for mobile robot not respecting exactly the ideal kinematic constraints, control laws taking into account the fast dynamics related to the contact effects wheels/ground, but not requiring the measurement of the actual values of the sliding velocities. The design procedure is based on a singular perturbation formulation of the robot model, and on the "slow manifold" approach. Two feedback control laws have been analysed, both of them being obtained as a modification of the standard linearizing control law based on the ideal model. The first control law is designed in order to achieve input-output linearisation of the non ideal robot on the corresponding slow manifold. The control, as well as the characterization of the slow

manifold, is obtained under the form of a power series expansion, whose first term is the ideal control law. For practical implementation however this development is truncated. The second method is an application of the " Lyapunov redesign approach ". The control law is designed in order to ensure that a Lyapunov function is decreasing on the corresponding slow manifold. The implementation of this method does not longer require a series expansion and a truncation. For both method the stability of the closed-loop system has been analysed and the theoretical results have been illustrated by numerical simulations.

For ideal wheeled mobile robots we have designed an open loop control law allowing one to steer the robot along a prespecified geometric path, minimizing a given cost index and satisfying a set of dynamical constraints. Using the concept of " differential flatness " the problem is shown to be equivalent to the selection of optimal time parametrization of the geometric path. This parametrization is characterized by a differential equation involving a function of the curvilinear coordinate along the path. For the minimum time problem, as well as for another index, such as the maximum value of the transversal acceleration, to be minimized over a given time interval, the problem reduces to the optimal choice of this function of the curvilinear coordinate. Using spline functions interpolation, the problem reduces to a finite parameter optimization problem.

Keywords : control, modelling, optimization

References : 98.81, 98.56

4 System Identification

4.1 Identification and validation for robust control design

(B.D.O. Anderson, P. Ansay, X. Bombois, B. Codrons, F. De Bruyne, M. Gevers, G. Scorletti, V. Wertz)
The work initiated at Cesame on system identification for robust control and on model validation for robust control has been pursued and extended in 1999. The major new extension has been in the direction of *controller validation*: necessary and sufficient conditions have been derived under which a given controller stabilizes all models in a model set validated by prediction error identification methods. These results have significantly narrowed the gap that existed between prediction error identification and robust control theory.

In addition to these necessary and sufficient condition results on controller validation, work has continued on the following topics that had been launched earlier.

- The Model Error Model approach to model validation, initially proposed by Ljung in 1997, has been replaced by a straightforward identification step using a full order model structure. The corresponding uncertainty sets have been completely characterized, for both open and closed loop identification, using direct or indirect methods.
- We have shown the benefits of using the dual Youla parametrization in iterative identification for control schemes.
- We have established new connections between the experimental conditions under which a validation experiment is conducted, the size of the corresponding uncertainty set, and the set of controllers that stabilize all models in such uncertainty set.

Keywords : Identification, control

References : 98.48, 98.72, 98.73, 98.91, 99.11, 99.12

4.2 Identification of nonlinear systems

(B. David, G. Bastin, V. Wertz, A. Lendasse, M. Hadjili, B.D.P. Anderson, F. De Bruyne, M. Gevers, N. Linard)

Identification of nonlinear systems using neural networks has started as a new activity in 1999. The research focuses on the prediction of time series with exogeneous inputs with applications to financial

time series and electricity consumption. We address the problem of dimension reduction using nonlinear projection methods (CCA (curvilinear component analysis), VQP (vector quantization and projection)).

A maximum likelihood parameter estimation method for nonlinear dynamical systems has been developed. The method relies on an autoregressive representation of the output errors to build an estimate of the inverse covariance matrix using the Gohberg-semencul formula. The usefulness of the method has been illustrated via Monte Carlo experimental validation on a pilot plant. It clearly appears that the proposed method widely improves the statistical properties of the estimators, in particular the quality of the confidence region around the parameter estimates.

Takagi Sugeno fuzzy models are also studied as a class of non linear models. A systematic procedure to perform the most important structure choices (member of antecedents, choice of antecedents, number of rules, ...) is under study.

An identification scheme using a tailor-made parametrization has been developed for the identification of closed-loop systems in which the system and/or the controller can be nonlinear. The ideas of the scheme, and in particular the computation of the gradient of the identification criterion, rely heavily on the recently developed model-free data-driven control design methods such as IFT. Indeed, the new identification scheme is in fact the dual of the control design scheme.

Keyword : Identification

References : 99.08, 99.80, 99.81, 99.84, 99.89

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 : 99.18, 99.23, 99.33, 99.70

5.2 Passivity approach

(R. Gorez, G. Calcev, V. Wertz)

Another work in the area of fuzzy models has been devoted to the control of singularly perturbed systems. This is a joint work with G. Calcev, formerly at CESAME and now with Motorola Company in the U.S. In this work, passivity properties are used in order to prove the stability of singularly perturbed systems controlled by a Takagi-Sugano fuzzy controller

Keyword : Fuzzy Control

References : 98.46, 98.121, 99.33

6 Analysis and control of infinite-dimensional systems

(K. Avowlanou, C. Delattre, D. Dochain)

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), Elarbi Achhab et Mohammed Laabissi (El Jadida, Maroc), Michel Perrier et Stéphane Renou (Ecole Polytechnique de Montréal, Canada), Isabelle Queinnec (LAAS-CNRS, France), L. Lefèvre (INPG, Valence, France).

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 pulp and paper bleaching processes and to wastewater biological pretreatment processes.
- Analysis of the reduction methods for distributed parameter (bio)chemical process models

Keyword : Control

References : 99.24, 99.38, 99.82

7 Biomedical engineering.

(P. Lefèvre, A. Coimbra, S. de Brouwer, G. Blohm, D. Yuksel, P.Y. Willems)

7.1 Gaze orientation

Our approach to biomedical engineering focuses on the application of systems analysis methodologies to the investigation of neural control of movement and its interaction 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 99, 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) [98.126]. At the same time, we pursued the experimental study of eye-head coordination in the cat. One journal article was published, comparing the generation of eye-head movements to visual targets with movements evoked by SC electrical stimulation [99.60, doctoral thesis of A. Coimbra: 99.98]. Our work led to major breakthrough in the interpretation of electrically evoked movements that were shown to be controlled in open loop, in contrast with visually evoked movements that are controlled in closed loop. This contribution brings new insight on the interpretation of experimental results on movements evoked by electrical stimulation of the SC.

We also described a new population of neurons in the Nucleus Interstitialis Cajalis (NIC) that have a discharge correlated with both saccadic and smooth pursuit eye movements (publication of a journal article [99.78]). NIC neurons play an important role because they are the substrate for an interaction between saccades and smooth pursuit, two types of eye movements that were classically assumed to be completely independent .

We also pursued a project on the behavioral and theoretical study of the interaction between saccadic and smooth pursuit eye movemens. This was investigated in the cat and we obtained preliminary data extending our findings to the human (in collaboration with Dr. G. Barnes, Institute of Neurology, London, UK).

References : 98.126, 99.60, 99.78, 99.98

7.2 Analysis of pathological human gait

The investigation of the cinematological properties of the knee and the shoulder has been completed. The parameters of these joints can be estimated from purely external (non invasive) measurements and the accuracy of the results is fully compatible with the accuracy required for gait analysis. (see references below)

The investigation of a general six degrees of freedom joint is presently under development. Such a joint which is independent of the actual model of a particular human joint, could prove to be useful to represent a series of joints with small relative displacements, the spinal cord in particular.

Corresponding inverse models will then be investigated in order to determine the various interactions in the joints and, possibly, to detect abnormal muscle actions. It is also intended to use these inverse models to improve the design of the prostheses used to facilitate pathological gait (research in collaboration with other European institutions).

References : 98.99, 98.100, 99.39

8 Multicriteria decision support tools with applications to sustainable development issues

(M. Installe, 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 progresses in the future. Hence, the present research explores new ways to integrate those lacks of knowledge in the models through the use of fuzzy concepts (fuzzy numbers, fuzzy relationships, ...). Recent (i.e. 1999) research progresses include : the consideration of the robustness of the problem solution with respect to the uncertainty of the problem parameters and the implementation of an algorithm to manage it, the assessment of the risks related to the fuzzy criteria' values, the assessment of the risk related to the violation of the fuzzy constraints of the problem, the consideration and the management of the fuzzy decision variables. Applications like i) 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 profit margin for the producers - has been analyzed through the (partially) implemented decision support tools and discussed with agricultural scientists ; ii) the determination of optimal investments schemes in long-term planning of electrical energy supply are currently under study.

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 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. They were summarized in a paper presented at the European Control Conference (*Reference 98.122*) and in a paper published in Systems and Control Letters (*Reference 98.62*)

References : 98.122, 98.62

9.2 Fault detection and isolation for gas turbine engines

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

In the framework of a Brite-Euram project we are developing a methodology for fault detection and isolation for gas turbine engines. The engine is described by a complex model involving about 20 state variables (temperatures, pressures, velocities along the gas flow), and characterized by 11 "health parameters". The problem consists in detecting, from measured data, possible changes of these parameters from their nominal values. The method we develop is based on the statistical local approach. We derived an "incremental" algorithm for isolation allowing us to isolate an unknown number of faults, without being extremely conservative. It has been tested on a steady-state model of the engine but will be extended to the transient model.

References: 99.3, 99.20, 99.21, 99.51, 99.75

9.3 Modelling and control of biotechnological systems

(O. Bernard, L. Chen, G. Bastin)

A new mechanistic simulation model for vanillin production by the fungus *Pyconoporus Cinnabarinus* has been developed.

A peak seeking method to approach the maximum biomass production rate in a continuous stirred tank bioreactor has been developed. It has been shown that the peak seeking scheme achieves optimization from both Monod and Haldane kinetics. A stabilizing feedback controller with a washout filter was designed to extend the operating range.

References : 98.35, 98.78, 99.30

9.4 Control of chemical processes

(F. Jadot, F. Viel, G. Bastin)

The robust stabilisation by output feedback of exothermic unstable processes operated in continuous stirred tank reactors has been investigated. The proposed control law is a dynamic temperature feedback which can be interpreted as a straightforward modification of a standard PI controller. In accordance with the engineering constraints, the control action is positive and saturated. With this control law, it has been shown that the temperature may be regulated at prescribed set point despite a wide kinetic uncertainty. Furthermore, the controller achieves a global stabilisation of the process in its domain of physical existence.

Reference : 98.34

9.5 Modelling and control of industrial Grinding Processes

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

Plugging is well known to be a major cause of instability in industrial grinding processes. A simple nonlinear model which is able to reproduce the plugging phenomenon in a realistic way has been developed. A state feedback controller based on this model has been designed. It is built on a nonlinear predictive control strategy. With this controller, the nominal performance of the closed loop system is improved and the risk of plugging is significantly reduced.

References : 98.55, 97.20

9.6 Control of Hydraulic Systems

(G. Bastin, L. Moens)

This research deals with the regulation of irrigation canals. The level and velocity control in a single reach delimited by two regulation gates and modelled by partial differential Saint Venant equations has been considered. Using the entropy as Lyapunov function, boundary control laws are derived which need only pointwise level measurement and are therefore meaningful from an engineering viewpoint. The

effectiveness of the approach is illustrated with simulations.

Reference : 98.84

10 Numerical methods in systems and control

10.1 Structured matrix problems

(Y. Genin, Y. Hachez, Y. Nesterov, P. Van Dooren)

Structured matrix problems arise in many problems of systems and control. The standard matrix structures that one encounters are Toeplitz and Hankel matrices. These matrices are encountered in problems of optimization, identification of multidimensional models.

We work on structured matrix problems involving Hankel and Toeplitz matrices. A recent survey makes connections between well known concepts related to Hankel matrices. It has been shown that a lossless function can be associated with any positive definite Hankel matrix. As a consequence, it appears that several mathematical problems involving Hankel matrices can be approached in a simplified and unified manner. In particular, it turns out that Hankel matrix extension problems admit straightforward solutions when revisited from this point of view. We also considered optimization problems over structured matrices. These show up when imposing positivity conditions on dynamical systems : a transfer function $T(\cdot)$ is positive real if and only if $T(\cdot) + T(\cdot)^*$ is positive on the boundary of the stability region (the $j\omega$ axis for continuous-time systems and the unit circle for discrete-time systems). The condition that a dynamical system is positive real can be expressed in terms of the so-called positive real lemma, and we showed that for polynomial models this problem can be rephrased as a linear matrix inequality, whose dual formulation involves Toeplitz and Hankel matrices. This formulation then allows to use efficient interior point methods in order to solve optimization problems over the convex set of positive polynomial models.

Keywords : structured matrices, optimization, positive functions, filter design

References : 99.68, 99.69

10.2 Distance and robustness problems

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

Robustness of a particular property of a dynamical system can be expressed as a distance measure of the nominal system to the set of undesired systems, such as the distance of a stable system to the unstable ones.

We work on distance and robustness issues of stability of a dynamical system. When such a system is modeled using a state space representation $\{A, B, C\}$ the robustness of its stability is connected to the so-called *stability radius* of the matrix A . For generalized state space models $\{\lambda E - A, B, C\}$ and polynomial models $\{T(\lambda), U(\lambda), V(\lambda), W(\lambda)\}$ one can define the stability radius in much the same manner. The roots of the generalized eigenvalue problem $(\lambda E - A)$ or of the polynomial matrix $P(\lambda)$ and their robustness, then define the stability radius. Analytical formulations of this robustness measure were obtained and computational methods for computing this robustness measure were derived for these models. The more complex problem of *real* perturbations was also considered but in this more general case only partial results were obtained so far. We are also considering extensions to discrete-time periodic systems and to other choices of norms than the 2-norm. For the 2-norm, this problem happens to be closely linked with μ -analysis.

Keywords : robustness, stability radius, optimization

References : 99.27,

10.3 Large-scale dynamical systems

(Y. Chahlaoui, P. Van Dooren)

Large-scale dynamical systems arise in many discretization problems of continuum problems, such as chemical, mechanical or physical phenomena. The discretized models can be quite large but are then typically sparse.

We have an activity in model reduction of large-scale dynamical systems. We study Krylov based methods and more precisely the two-sided Krylov algorithm related to the unsymmetric Lanczos reduction. We analyzed the sensitivity of this reduction using elementwise perturbation theory. This analysis shows that the unsymmetric Lanczos reduction can be much more sensitive than its symmetric counterpart. Rigorous bounds for the sensitivity have been derived. A comparison of Krylov based methods with more conventional model reduction techniques such as balanced truncation or Hankel norm approximation, showed that Krylov based methods are more flexible and more economical and yet can provide a very good fit of the frequency response. We also wrote a survey of recent techniques in the area of model reduction based on Gramians and energy functions and showed how these can be extended to time varying models and non-linear models. These ideas make nice connections with principal orthogonal decompositions used in the PDE literature. We also show how such techniques can be used to solve stabilization of large scale dynamical systems at a reasonable cost. The techniques are related to the Chandrasekhar recurrences and to fast Kalman filter implementations. In connection with this, we also look at solving large systems of indefinite equations appearing in the context of Support Vector Machines for Neural Networks.

Keywords : model reduction, Lanczos algorithm, Krylov spaces

References : 98.103, 98.6, 98.68, 99.29, 99.9

10.4 Orthogonal transformations and functions

(R. Sepulchre, J. Sreedhar, P. Van Dooren)

Orthogonal functions and transformations are the cornerstone of many numerical methods with guaranteed accuracy bounds and hence are of vital importance in many basic numerical techniques.

We work on basic orthogonal matrix decompositions and their use in several numerical linear algebra problems arising in systems and control. A survey was written for the Wiley Encyclopedia of Electrical and Electronics Engineering on such decompositions and their use in systems and control. Special decomposition for quadruples of matrices related to state space models and for sequence of matrices occurring in two point boundary value problems or periodic systems were also derived. We also looked at a new geometric interpretation of the Rayleigh quotient iteration for subspaces in order to establish its convergence properties.

Keywords : Orthogonal transformations, eigenvalue problems

References : 99.1, 97.71, 96.117, 97.57, 98.105

10.5 Software development

(D. Kressner, C. Lecomte, N. Mastronardi, P. Van Dooren, S. Van Huffel)

Numerical software is often of capital importance in the transfer of technology to industry. New mathematical and numerical ideas are easier to convey when implemented in user friendly software packages.

The activity of software development for system identification and control is a collaboration with KUL/ESAT. Efficient and reliable algorithms and associated software for system identification and control are highly desirable both in industry and academia. New tools have been developed and integrated into the **SLICOT Library** which is the most important deliverable of the Numerics in Control Network NICONET. To increase the user-friendliness, MATLAB interfaces have been developed for the basic computational routines. The main algorithmic and software developments include the computation of periodic Hessenberg and Schur forms, an improved solver for Riccati equations, condition estimators for Lyapunov and Riccati equations, new routines for system identification based on subspace techniques, and associated mathematical routines such as the solution of special least-squares problems. A section on parallel algorithms for systems and control is being put together by the collaborating teams of UP Valencia and TU Bremen.

Keywords : numerical algorithms, MATLAB, software

Reference : 99.72

11 Complexity of dynamical systems and control design

(V. Blondel, J. Tsitsiklis)

Many crucial questions in systems and control are simple to state in mathematical terms but are 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. It is pursued in collaboration with J. Tsitsiklis (MIT) and P. Koiran (ENS Lyon).

In 1999, we have proved, together with O. Bournez (INRIA Lorraine), P. Koiran (ENS, Lyon) and J. Tsitsiklis (MIT, Cambridge), that a conjecture of E. Sontag is true, namely that the global convergence of systems with componentwise nonlinearities is undecidable.

We have also analysed, together with S. Gaubert (INRIA Rocquencourt) and J. Tsitsiklis (MIT, Cambridge), the complexity of computing Lyapunov exponents in the max-plus algebra, which is an algebra that is appropriate for describing a particular class of discrete-event systems.

Finally, in collaboration with M. Vidyasagar (CAIR, Bangalore), we have derived algorithms for NP-hard matrix problems.

References : 98.117, 99.40

12 Micro-Macro Approach in Computational Rheology

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

We study the rheological behaviour and dynamics of complex fluids, such as polymer solutions, melts, and liquid crystals, using a combination of theoretical and numerical tools. The underlying theoretical picture is that of non-linear continuum mechanics and kinetic theory of materials endowed with a microstructure. Work is performed on the development and use of suitable numerical techniques and algorithms (finite elements, stochastic techniques, parallel computing) for the computer simulation of rheologically-complex fluids. Research is also underway on the development and evaluation of constitutive equations and kinetic theory models describing the rheology of polymeric liquids. In 1999, our main new developments in this area have been the following: (i) design, implementation, and validation of the so-called Adaptive, and Backward-tracking, Lagrangian Particle Methods (ALPM and BLPM) for simulating 2d transient flows of polymeric fluids using either a differential constitutive equation (macro approach) or a model of kinetic theory (micro-macro approach); (ii) completion of our work on new closure approximations to obtain constitutive equation for dilute polymer solutions, capable, in particular, of reproducing hysteretic behaviour.

Keywords : polymers, rheology, mathematical modeling, computer simulation, continuum mechanics, kinetic theory, stochastic simulation, finite elements, parallel computing.

References : 98.41, 98.86, 99.13, 99.26, 99.62

13 Crystal growth

(F. Dupret, N. Van den Bogaert, V. Regnier, Roman Rolinsky, Wu Liang)

The principal research directions of this group have been (i) to develop an integrated software for the prediction of the entire growth process (from seeding to tail-end and after-growth stages, and for the Czochralski, Floating Zone and Vertical Bridgman processes); (ii) to develop relevant "axisymmetric averaged" flow models, in order to take into account the effect of flow structured oscillations and turbulence on the global heat transfer in the furnace; (iii) to pursue the development of a 3D unsteady flow software in order to analyse melt flow details; (iv) to pursue the set-up of an experimental apparatus for the analysis of the 3D transient melt flow; (v) to analyse the effect of rotating magnetic fields in semi-conductor growth; (vi) to pursue theoretical investigations on visco-plastic models for the calculation of dislocation density and residual stresses in the cooled crystal; (vii) to pursue investigations on defect formation in silicon crystals; and (viii) to participate in the development of regulation methods to

control the Czochralski growth process. 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). The development of a new software generation (FEMAG 2.xx) has been decided, with user-friendly interactive pre- and post-processors and the above items (i) and (ii) as primary objectives.

References : 99.107, 99.113, 99.114

14 Injection moulding

(F. Dupret, C. Jeggy, O. Magotte, F. Loix)

The development of a software for the prediction of micro-injection moulding (i.e., the moulding of small or very small parts, with a tolerance in the micro range) is now the major goal for this class of research activities, and 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 continued. A re-meshing algorithm has been designed and developed in order to perform finite element calculations on the evolving 3D flow domain.

A new objective has been to develop a fully 3D simulation software for the Resin Transfer Moulding (RTM) and Structural Reaction Injection Moulding (SRIM) processes. In these cases, the model is governed by the physics of flows in porous media (the fibre mat is the porous medium), and the effects of anisotropic permeability and mechanical dispersion must be considered.

References : 98.155, 98.158, 99.109, 99.110

15 Deformation, damage and fracture of engineering materials

(I. Doghri, S. Nikolov, L. Zealouk, O. Pierard, A. Ouaar, O. Abbab)

Our main research area is the mathematical modeling and numerical simulation of the deformation, damage and fracture of engineering materials. This may also be designated as "computational mechanics of solid materials". The final aim is to develop robust computer software in order to simulate the behavior of engineering materials in the nonlinear regime (e.g., plasticity, viscoplasticity, nonlinear elasticity, damage). The numerical results are validated by comparison against available experimental data.

Our efforts have been directed recently towards "multi-scale mechanics of materials", that is the prediction of the macroscopic behavior from the microstructure. Within this framework, on going research projects are the following:

1. Micro/macro modeling and simulation of the deformations of semi-crystalline polymers (with S. Nikolov, L. Zealouk and O. Pierard)
2. Two-scale modeling and simulation of fiber-reinforced materials (with A. Ouaar et J.-F. Thimus)
3. Multi-scale numerical simulation of crystalline materials (with O. Abbad).

References : 97.58, 98.93, 99.17

16 Micro-tip forming

(F. Dupret, S. Clain)

The research activity started in 1997, in order to investigate the formation of micro-tips and micro-blades by chemical erosion, has been pursued. A publication is in preparation.

17 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). 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 recent developments, both in 2-D and 3-D include: (1) the treatment of the no-slip boundary condition (by computation of M vortex panels on the body surface, in $O(M \log M)$ operations, and then diffusion of the panels onto the vortex particles, (2) the possibility of handling bodies of arbitrary geometry (i.e., with arbitrary crossing between the body surface and the particle redistribution lattice), and (3) the possibility of having a non-uniform spatial resolution (fine near the body, coarser in the far wake). In 3-D, all this has allowed the lagrangian simulation of the unsteady flow past a sphere at $Re=300$ and for a very long development time ($T=30$). This research is done in close collaboration with Prof. A. Leonard and Dr. J. K. Salmon (California Institute of Technology). This collaboration also provides access to very high performance parallel computing.

Local 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

References : 98.149, 99.106

18 Large Eddy Simulation (LES) of turbulent flows

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

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 filtered-scale and 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.

Another aim is the development and validation of approximate wall boundary conditions for LES, which would allow to perform LES without having to resolve the wall proximity region.

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

19 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 particle 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.

3. Publications

EDITED BOOK

- 98.133 BLONDEL V., E.SONTAG, M. VIDYASAGAR, J. WILLEMS, "Open Problems in Mathematical Systems and Control Theory", Springer Verlag London, 1998.

CHAPTERS IN BOOKS

- 98.103 GALLIVAN K.A., GRIMME E., P. VAN DOOREN, "Model Reduction of Large-Scale Systems Rational Krylov Versus Balancing Techniques", *NATO ASI Series, Error control and adaptivity in scientific computing*, vol. 536, pp. 177-190, 1999.
- 98.117 BLONDEL V., N. TSITSIKLIS, "Three problems on the decidability and complexity of stability", *Open problems in mathematical systems theory and control*, Eds . V. Blondel, E. Sontag, M. Vidyasagar and J. C. Willems, Springer Verlag, (11) pp. 45-52, 1999.
- 98.118 BLONDEL V., "Simultaneous stabilization of linear systems and interpolation with rational functions", *Open problems in mathematical systems theory and control*, Eds. V. Blondel, E. Sontag, M. Vidyasagar and J. Willems, Springer Verlag, (12), pp. 53-60, 1999.
- 98.130 INSTALLE M., B. GAILLY, "A new DSS for incentive strategies : Application to a rural development problem in Central Africa", *Decision Support Tools for a Sustainable Developing Countries : a resource book of methods and applications*, G. Kersten, Z. Mikolajuk and A. Gar-On Yeh (Eds), Kluwer Academics Publishers, pp. 131-144, 1999.
- 98.155 DUPRET F., A. COUNIOT, O. MAL, L. VANDERSCHUREN, O. VERHOYEN, "Modelling and Simulation of Injection Moulding", chapter of "Advances in the Flow and Rheology of Non-Newtonian Fluids", D.A. Siginer, D. De Kee and R.P. Chhabra editors, Rheology Series, Elsevier, Amsterdam, 1999, pp. 939-1010.
- 98.116 DUPRET F., V. VERLEYE, "Modelling the Flow of Fiber Suspensions in Narrow Gaps", chapter of "Advances in the Flow and Rheology of Non-Newtonian Fluids", D.A. Siginer, D. De Kee and R.P. Chhabra editors, Rheology Series, Elsevier, Amsterdam, 1999, pp. 1347-1398.
- 99.01 VAN DOOREN P., "Orthogonal matrix decompositions in systems and control", *NATO ASI Series, Error control and adaptivity in scientific computing*, Vol. 536, pp. 159-175, 1999.
- 99.04 ORTEGA R., A. ASTOLFI, G. BASTIN, H. RODRIGUEZ-CORTES, "Output feedback control of food-chain systems", *New Directions in Nonlinear Observer Design, Lecture notes in Control and Information Sciences*, H. Nijmeier and T.I. Fossen Eds, pp. 291-310, 1999.
- 99.12 GEVERS M., X. BOMBOIS, B. CODRONS, F. DE BRUYNE, G. SCORLETTI, "The Role of Experimental Conditions in Model Validation for Control", *Robustness in Identification and Control*, *Lecture notes in Control and Information sciences*, A. Garulli, A. Tesi and A. Vicino ed., Springer Verlag, Vol. 245, pp. 72-86, 1999.
- 99.16 BASTIN G., "Issues in modelling and control of mass balance systems", *Stability and stabilization of nonlinear systems* Ed. by D. Aeyels, F. Lamnabhi Lagarrigue and A.J. Van der Schaft, *Lecture Notes in Control Information Sciences*, no 246, Springer Verlag, pp. 53-74, 1999.
- 99.71 BLONDEL V., O. BOURNEZ, P. KOIRAN, J.N. TSITSIKLIS, "The stability of saturated linear dynamical systems is undecidable", *Accepted in Theoretical Aspects of Computer Science (STACS 2000)*, H. Reichel, S. Tison (Eds), *Lecture notes in Computer Science*, Heidelberg, 1999.
- 99.72 VAN DOOREN P., "Software for control system analysis and design, singular value decomposition", *Wiley Encyclopedia of Electrical and Electronics Engineering*, Ed. Webster, Wiley and Sons, Vol. 18, pp. 464-473, 1999.
- 99.97 VERLEYSSEN M., E. DE BODT, A. LENDASSE, "Forecasting financial time series through intrinsic dimension estimation and non-linear data projection", *Engineering applications of bio-inspired artificial neural networks*, Springer, *Lecture notes in Computer Science 1607*, J. Mira, Juan V. Sanchez-Andres eds, pp. II.596-II.605, 1999.
- 99.107 SINNO T., E. DORNBERGER, R.A. BROWN, W. VON AMMON, F. DUPRET, "Defect engineering of single-crystal silicon : linking point defect dynamics with Czochralski crystal growth", *Accepted in Materials Science and Engineering : R Reports*.

PUBLISHED JOURNAL PAPERS

- 95.07 BASTIN G., F. JARACHI, I.M.Y. MAREELS, "Output dead beat control of nonlinear discrete time systems with one-dimensional zero dynamics : global stability conditions", *IEEE Transactions on Automatic Control*, Vol. 44 (6), pp. 1262-1266, 1999.
- 96.12 ACHHAB M.E., V. WERTZ, "On Reachable Sets for a Class of Nonlinear Systems with Constraints", *Journal of Mathematical Analysis and its Applications*, vol 229, pp. 105-118, 1999.
- 97.20 MAGNI L., G. BASTIN, V. WERTZ, "Multivariable Nonlinear Predictive Control of cement mills", *IEEE Transactions on Control Systems Technology*, Vol 7, no 4, pp. 502-508, 1999.
- 97.54 JANKOVIC M., R. SEPULCHRE, P.V. KOKOTOVIC, "CLF Based designs with robustness to dynamic input uncertainties", *Systems and Control Letters*, vol. 37, pp. 45-54, 1999.
- 97.58 KNOCKAERT R., I. DOGHRI, "Nonlocal constitutive models with gradients of internal variables derived from a micro/macro homogenization procedure", *Computer Methods in Applied Mechanics and Eng.*, vol 174, pp. 121-136, 1999.
- 97.71 SREEDHAR J., P. VAN DOOREN, "Periodic Descriptor Systems : Solvability and Conditionability", *IEEE Automatic Control*, Vol.44, no 2, pp. 310-313, 1999.
- 97.85 NESIC D., G. BASTIN, "Stabilizability and dead-beat controllers for two classes of Wiener-Hammerstein models", *IEEE Transactions on Automatic Control*, vol. 44(11), pp. 2068-2071, 1999.
- 98.06 PAIGE C.C., P. VAN DOOREN, "Sensitivity Analysis of the Lanczos Reduction", *Numerical linear algebra with applications*, Vol.6, pp 29-50, 1999.
- 98.34 JADOT F., BASTIN G., VIEL F., "Robust global stabilisation of stirred tank reactors by saturated output feedback", *European Journal of Control*, Vol.5, pp. 361-371, 1999.
- 98.35 WANG H.H., KRSTIC M., G. BASTIN, "Optimizing Bioreactors by Extremum Seeking", *Int. J. Adaptive Control and Signal Processing*, Vol. 13, pp. 651-669, 1999.
- 98.41 SIZAIRE R., G. LIELENS, I. JAUMAIN, R. KEUNINGS, V. LEGAT, "On the Hysteretic Behaviour of Dilute Polymer Solutions in Relaxation Following Extensional Flow", *Journal of Non-Newtonian Fluid Mechanics*, Vol. 82, pp. 233-253, 1999.
- 98.62 GOREZ R., "Globally stable PID-like control of mechanical systems", *Systems and Control Letters*, vol.38, pp. 61-72, 1999.
- 98.68 GALLIVAN K., P. VAN DOOREN, "Rational approximations of pre-filtered transfer functions via the Lanczos algorithm", *Numerical Algorithms*, vol. 20, pp. 331-342, 1999.
- 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", *Biotechnology and Bioengineering*, vol. 65(5), pp. 558-571, 1999.
- 98.86 GALLEZ X, P. HALIN, G. LIELENS, R. KEUNINGS, V. LEGAT, "The adaptive Lagrangian Particle Method for Macroscopic and Micro-Macro Computations of Time-Dependent Viscoelastic Flows", *Computer Methods in Applied Mechanics and Engineering*, Vol. 180, pp. 345-364, 1999.
- 98.99 BAO H., P.Y. WILLEMS, "On the kinematic modelling and the parameter estimation of the human shoulder", *Journal of Biomechanics*, Vol 32, pp. 943-950, 1999.
- 98.100 BAO H., P.Y. WILLEMS, "On the kinematic modelling and the parameter estimation of the human knee joint", *Journal of Biomechanical Engineering*, Vol 121, pp. 406-413, 1999.
- 98.119 GROGNARD F., R. SEPULCHRE, G. BASTIN, "Slow control for global stabilization of feedforward systems with exponentially unstable Jacobian linearization", *Systems and Control Letters*, Vol. 37(2), pp. 107-115, 1999.
- 98.126 QUAIA C., P. LEFEVRE, L.M. OPTICAN, "Model of the control of saccades by Superior Colliculus and Cerebellum", *Journal of Neurophysiology*, Vol. 82, pp. 999-1018, 1999.
- 99.28 DOCHAIN D., Process control strategy and optimization, *Encyclopedia of Bioprocess Technology : Fermentation, Biocatalysis, and Bioseparation*, M.C. Flickinger, S.W. Drew, John Wiley & Sons, pp. 2048-2056, 1999.

- 99.39 BAO H., P.Y. WILLEMS, "Parameter estimation of fixed-distance joints", *Archive of Applied Mechanics*, Vol. 69, pp. 465-479, 1999.
- 99.40 BLONDEL V., J. N. TSITSIKLIS, "Complexity of stability and controllability of elementary hybrid systems", *Automatica*, Vol. 35 (3), pp. 479-489, 1999.
- 99.84 DE BRUYNE F., B.D.O. ANDERSON, M. GEVERS AND N. LINARD, "Gradient expressions for a closed-loop identification scheme with a tailor made parametrization", *Automatica*, vol. 35, n° 11, pp. 1867-1871, november 1999.
- 99.95 ABSIL P.A., R. SEPULCHRE, A. BILGE, P. GERARD, "Nonlinear analysis of cardiac rythm fluctuations using DFA method", *Physica A 272*, pp. 235-244, 1999.
- 99.96 MAZENC F., R. SEPULCHRE, M. JANKOVIC, "Lyapunov functions for stable cascades and applications to stabilization", *IEEE Transactions on Automatic Control*, vol. 44, no 9, pp. 1795-1800, 1999.
- 99.99 NESTEROV Y., J.PH. VIAL, "Homogeneous analytic center cutting plane methods for convex problems and variational inequalities", *SIAM J. Optim.*, Vol. 9, no 3, pp. 707-728, 1999.
- 99.100 NESTEROV Y., "Squared functional systems and optimization problems", *High Performance Optimization*, H. Henk et al, eds, Kluwer, Chapter 17, pp. 405-440, 1999.
- 99.104 ATALLA N., G. WINCKELMANS, F. SGARD, "A multiple multipole expansion approach for predicting the sound power of vibrating structures", *J. Acustica - acta acustica*, bf 85, pp. 47-53, 1999.
- 99.113 GONDET S., T. DUFFAR, G. JACOB, N. VAN DEN BOGAERT, F. LOUCHET, "Thermal stress simulation and interface destabilisation in indium phosphide grown by LEC process", *J. Cryst. Growth*, 198/199 (1999) 129-134.
- 99.114 GONDET S., T. DUFFAR, G. JACOB, N. VAN DEN BOGAERT, F. LOUCHET, "Improvement of crystalline quality of 3-inch InP wafers", *Jpn. J. Appl. Phys.*, Vol. 38 (1999) 972-976.

PAPERS ACCEPTED FOR PUBLICATION

- 95.137 GAILLY B., INSTALLÉ M., Y. SMEERS, "A new resolution method for the parametric linear complementarity problem", *Accepted for publication in the European Journal of Operation Research*, 1999.
- 96.74 BOURREL S., D. DOCHAIN, J.P. BABARY, I. QUEINNEC, "Modelling, Identification and Control of a Denitrifying Biofilter", *Accepted to Journal of Process Control*, (to appear in 2000), 1999.
- 96.117 STEWART M., P. VAN DOOREN, "Conditioning in the application of S-orthogonal transformations", *Accepted to SIAM Journal of Matrix Analysis and Applications*, 1999.
- 96.118 STEWART M., P. VAN DOOREN, "An updating algorithm for a generalization of a URV decomposition", *Accepted to SIAM Journal of Matrix Analysis and Applications*, 1999.
- 97.03 WINKIN J., D. DOCHAIN, PH. Ligarius, "Dynamical Analysis of a class of a Distributed Parameter Tubular Reactors", *Automatica*, (to appear in 2000), 1999.
- 97.23 SEPULCHRE R., "Slow Peaking and Low-Gain Designs for Global Stabilization of Nonlinear Systems", *Accepted to IEEE Transactions on Automatic Control*, (to appear in march 2000), 1999.
- 97.57 GOLUB G., K. SOLNA, P. VAN DOOREN, "Computing the SVD of a general matrix product/quotient", *Accepted to SIAM Journal of Matrix Analysis and Applications*, 1999.
- 98.27 SIZAIRE R., V. LEGAT, "Three-Dimensional Numerical Prediction of the Encapsulation Effects for Polymer Melts" *Accepted to Journal of Rheology*, 1999.
- 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", *Control Engineering Practice*, (to appear in 2000), 1999.
- 98.93 NIKOLOV S., I. DOGHRI, "A micro/macro constitutive model for the small-deformation behavior of polyethylene", *Polymer*, (to appear in 2000), 1999.
- 98.108 DOCHAIN D., "State observers for tubular reactors with unknow kinetics", *Journal of Process Control*, (to appear in 2000), 1999.
- 98.120 AERNOUITS W., R. SEPULCHRE, D. ROOSE, "Delayed control of axial compressors", *Accepted to International Journal of Bifurcations and Chaos*, (to appear in March 2000), 1999.

- 98.133 BLONDEL V., E. SONTAG, M. VIDYASAGAR, J.C. WILLEMS, "Open Problems in Mathematical Systems and Control Theory", *Springer Verlag*, 1999.
- 99.5 GANG L., M. GEVERS, Y. SUN, "Performance Analysis of a New Structure for Digital Filter", *IEEE Trans. on Circuits & Systems*, (to appear in 2000), 1999.
- 99.26 WAPPEROM P., R. KEUNINGS, V. LEGAT, "The Backward-Tracking Lagrangian particle Method for Transient Viscoelastic Flows", *Accepted to the J. of Non-Newtonian Fluid Mechanics*, 1999.
- 99.41 BLONDEL V., J.N. TSITSIKLIS, "A survey of computational complexity results in systems and control", *Automatica*, (to appear in September 2000), 1999
- 99.42 BLONDEL V., R. RUPP, "Distortion theorems for rational functions without poles or zeros in simply connected domains", *Complex variables*, (to appear in September 2000), 1999.
- 99.58 BOURREL S., D. DOCHAIN, "Stability Analysis of Two Linear Distributed Parameter Bioprocess Models", *Mathematical and Computer Modelling of Dynamical System*, 1999.
- 99.59 CHEN L., O. BERNARD, G. BASTIN, P. ANGELOV, "Hybrid Modelling of Biotechnological Processes Using Neural Networks", *Control Engineering Practice*, (to appear in 2000), 1999.
- 99.60 COIMBRA A, P. LEFÈVRE, M. MISSAL, E. OLIVIER, "Difference between visually and electrically evoked gaze saccades disclosed by altering the head moment of inertia", *Accepted to Journal of Neurophysiology*, (to appear in 2000), 1999.
- 99.61 GROGNARD F., R. SEPULCHRE, G. BASTIN, "Improved performance of low-gain control for linear systems with saturated input", *Accepted to MTNS 2000*, Perpignan, France, 1999.
- 99.77 GENIN Y., "Hankel matrices, positive functions and related questions", *Accepted to Linear Algebra and its Applications (LAA)*, 1999.
- 99.78 MISSAL M., S. DE BROUWER, P. LEFÈVRE, E. OLIVIER, "Activity of mesencephalic vertical burst neurons during saccades and smooth pursuit", *Journal of Neurophysiology*, , 1999.
- 99.80 LENDASSE A., E. DE BODT, V. WERTZ, M. VERLEYSEN, "Non linear financial time series forecasting - Application to the Bel 20 stock market index", *European Journal of Economic and Social Systems*, (to appear in 2000), 1999.

PAPERS SUBMITTED FOR PUBLICATION

- 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 to Asian Journal of Control*, 1999.
- 98.94 DAVID B, G. BASTIN, "An estimator of the inverse covariance matrix and its application to ML parameter estimation in dynamical systems", *Submitted to Automatica*, 1999.
- 99.2 GROGNARD F., F. JADOT, L. MAGNI, G. BASTIN, R. SEPULCHRE, V. WERTZ, "Robust stabilization of a nonlinear cement mill model", *submitted to IEEE Trans. Aut. Cont.*, 1999.
- 99.13 LIELENS G., R. KEUNINGS, V. LEGAT, "The FENE-L and FENE-LS closure approximations to the kinetic theory of finitely extensible dumbbells", *Submitted for publication in the Journal of Non-Newtonian Fluid Mechanics*, 1999.
- 99.22 VAN VYVE, E., P. VANDERGHEYNST, A. GOLDBERG, J.-P. ANTOINE, I. DOGHRI, "Modelling and simulation of an impact test using wavelets, analytical solutions and finite elements", *Submitted in International Journal of Solids and Structures*, 1999.
- 99.25 GOREZ R., P. KLAN, "Tuning PI Controllers in two closed-loop experiments via a new design method", *Submitted for publication in Automatica*, 1999.
- 99.32 CODRONS B., B.D.O. ANDERSON, M. GEVERS, "Closed-loop identification with an unstable or nonminimum phase controller", *Submitted to Automatica*, 1999.
- 99.43 BLONDEL V., S. GAUBERT, J.N. TSITSIKLIS, "Approximating the spectral radius of sets of matrices in the max-algebra is NP-hard", *Submitted for publication in IEEE Transactions on Automatic Control*, 1999.

- 99.44 VIDYASAGAR M., V. BLONDEL, "Probabilistic solutions to some NP-hard matrix problems", *Submitted in Automatica*, 1999.
- 99.45 BLONDEL V., N. PORTIER, "Le problème de la réalisation minimale dans le demi-anneau max-plus et le problème de Pisot sont NP-durs", *Submitted to Comptes Rendus de l'Académie des Sciences de Paris*, 1999.
- 99.46 BLONDEL V., N. PORTIER, "The presence of a zero in an integer linear recurrent sequence is NP-hard to decide", *Submitted to Information and Control*, 1999.
- 99.47 BLONDEL V., O. BOURNEZ, P. KOIRAN, C. PAPADIMITRIOU, J.N. TSITSIKLIS, "Deciding stability and mortality of piecewise affine dynamical systems", *Submitted to Theoretical Computer Science*, 1999.
- 99.48 BLONDEL V., O. BOURNEZ, P. KOIRAN, J.N. TSITSIKLIS, "The stability of saturated linear dynamical systems is undecidable", *Submitted to Journal of Computer and System Sciences*, 1999.
- 99.50 BLONDEL V., J.N. TSITSIKLIS, "The boundedness of all product of a pair of matrices is undecidable", *Submitted to Systems and Control Letters*, 1999.
- 99.52 GROGNARD F., R. SEPULCHRE, G. BASTIN, "Improving the performance of low-gain designs for bounded control of linear systems", *Submitted to Automatica*, 1999.
- 99.56 PARRINI S., J. DELBEKE, V. LEGAT, C. VERAART, "A modelling analysis of human optic nerve fibres excitation based on experimental data", *Submitted in Medical & Biological Eng. and Comp.*, 1999.
- 99.62 KEUNINGS R., "Advances in the computer modeling of the flow of polymeric liquids", *Submitted in the Computational Fluid Dynamics Journal*, 1999.
- 99.63 KLAN P., R. GOREZ, "A New Approach to Iterative Tuning of PI Controllers", *Submitted for publication in the European Journal of Control*, 1999.
- 99.70 ESPINOSA OVIEDO J.J., M. HADJILI, V. WERTZ, J. VANDEWALLE, "Unconstrained Predictive Control Using Fuzzy Models-Comparative Study", *Submitted to Fuzzy Sets and Systems*, 1999.
- 99.79 BOMBOIS X., M. GEVERS, G. SCORLETTI, "A measure of robust stability for an identified set of parametrized transfer functions", *Submitted for publication to IEEE Transactions on Automatic Control*, 1999.
- 99.91 MICHIELS W., R. SEPULCHRE, D. ROOSE, "Stability of perturbed functional differential equations and stabilization of nonlinear cascades", *submitted to SIAM Journal of Control and Optimization*, 1999.
- 99.92 PEUTEMANS J., D. AEYELS, R. SEPULCHRE, "Boundedness results for time-varying nonlinear systems that are not slowly varying", *submitted to SIAM Journal of Control and Optimization*, 1999.
- 99.93 ABSIL P.A., R. SEPULCHRE, "Continuous dynamical systems that realize discrete optimization on the hypercube", *submitted to SIAM Journal of Control and Optimization*, 1999.
- 99.101 NESTEROV Y., "Stable traffic equilibria : properties and applications", *Accepted to Optimization and Engineering*, 1999.
- 99.106 PLOUMHANS P., G.S. WINCKELMANS, "Vortex methods for high resolution simulations of viscous flows past bluff-bodies of general geometry", *submitted to J. Comp. Phys.*, 1999.

PUBLISHED CONFERENCE PAPERS

- 98.48 BOMBOIS X., M. GEVERS, G. SCORLETTI, "Controller validation for a validated model set", *Proc. of European Control Conference (ECC 99)*, Karlsruhe, Germany, CD-Rom, paper 869, September, 1999.
- 98.53 LEQUIN O., M. GEVERS, L. TRIESTE, "Optimizing the settling time with Iterative Feedback Tuning, *14th IFAC World Congress*, Beijing, China, vol.1, pp. 433-437, July, 1999.
- 98.54 BASTIN G., L. PRALY, "Feedback stabilisation with positive control of a class of dissipative mass-balance systems", *Proc. 14th IFAC World Congress (IFAC 99)*, Beijing, China, Vol. C, Paper 2a-03-2, pp. 79-84, July, 1999.
- 98.55 WERTZ V., L. MAGNI, G. BASTIN, "Multivariable Nonlinear Control of Cement Mills", *Proc. Workshop on Nonlinear Predictive Control Ascona, Switzerland (June 98)*, 1999.
- 98.70 FAVOREEL W., B. DE MOOR, M. GEVERS, P. VAN OVERSCHEE, "Model-free subspace-based LQG-design", *ACC 99*, San Diego, pp. 3372-3376, June, 1999.
- 98.72 GEVERS M., B. CODRONS, F. DE BRUYNE, "Model Validation in Closed-Loop", *American Control Conference (ACC 99)*, San Diego, USA, pp. 326-330, June, 1999.
- 98.73 ANSAY P., M. GEVERS, V. WERTZ, "Identification with the Youla parametrization in identification for control", *Proc. ACC 99*, San Diego, USA, pp. 827-831, June, 1999.
- 98.77 BERNARD O., Z. HADJ-SADOK, D. DOCHAIN, "Dynamical Modelling and State Estimation of Anaerobic Wastewater Treatment Plants", *European Control Conference (ECC 99)*, Karlsruhe, Germany, CD-Rom paper F1028, session BM-10, July, 1999.
- 98.81 BENAYAD M.A., G. CAMPION, V. WERTZ, M.E. ACHHAB, "Time optimal steering for a mobile robot along a given path", *European Control Conference (ECC 99)*, Karlsruhe, Germany, July, CD-Rom, paper F243- Session CP11, 1999.
- 98.83 BOURREL S., D. DOCHAIN, "Dynamical Analysis of Tubular Bioreactor Models", *European Control Conference (ECC 99)*, Karlsruhe, Germany, CD-Rom paper F1016 - Session CA-6, July, 1999.
- 98.84 CORON J.M., B. D'ANDRÉA-NOVEL, G. BASTIN, "A Lyapunov approach to control irrigation canals modeled by Saint-Venant equations", *European Control Conference, (ECC 99)*, Karlsruhe, Germany, CD-Rom, Paper F1008-5, Session AP-10, July, 1999.
- 98.85 DAUTREBANDE N., G. BASTIN, "Positive linear observers for positive linear systems", *European Control Conference - ECC 99*, Karlsruhe, Germany, CD-Rom Paper F371, Session CP-9, July, 1999.
- 98.91 ANSAY P., M. GEVERS, V. WERTZ, "Closed-loop or open-loop models in identification for control?", *European Control Conference (ECC 99)*, Karlsruhe, Germany, CD-Rom, paper 544, July, 1999.
- 98.92 FAVOREEL W., B. DE MOOR, M. GEVERS, P. VAN OVERSCHEE, "Closed loop model-free subspace-based LQG-design", *Proc. of the IEEE Mediterranean Conference on Control and Automation*, Haifa, Israël, Paper TP5-4, June 28-30, 1999.
- 98.101 BERNARD O., G. BASTIN, P. ANGELOV, "Hybrid modelling of biotechnological processes using neural networks", *Proc. 14th IFAC World Congress (IFAC 99)*, Beijing, China, Vol. O, paper 7d-02-4, pp. 469-474, July, 1999.
- 98.104 BABARY J.P., S. JULIEN, C. GOMEZ-QUINTERO, D. DOCHAIN, "On linearizing control of an activated sludge process", *Proc. of the 14th IFAC World Congress*, Beijing, China, vol. O, pp. 433-438, July, 1999.
- 98.105 VAN DOOREN P., "Two point boundary value and periodic eigenvalue problems", *Proc. of International Symposium on Computer Aided Control System Design*, Hawaii, pp. 58-63, August 22-27, 1999.
- 98.121 GOREZ R., G. CALCEV, "Passivity-based analysis of gain scheduled feedback control loops", *Proc. of European Control Conference (ECC 99)*, Karlsruhe, Germany, CD-Rom, paper F1020-2 (BA-14), September, 1999.
- 98.122 GOREZ R., "Conclusions of 5-year investigations in sliding mode control of robot manipulators", *Proc. of European Control Conference (ECC 99)*, Karlsruhe, Germany, CD-Rom, paper F1029-5 (AM-13), September, 1999.

- 98.141 STANCIULESCU C., M. INSTALLE, "Multicriteria decision-making for agro-ecosystems planning under risk using fuzzy concepts", *50th meeting of European Working Group 'Multicriteria aid for decisions'*, Cerisy-la-Salle, France, pp .41-45, Septembre, 1999.
- 98.142 INSTALLÉ M., Introducing sustainability concepts in engineering curricula : a review and a synthesis of some implementations in European universities, *Proc. of ENTREE'99 Conf. on "Sustainable use of natural resources - cooperative planning and actions"*, Tampere, Finland, pp. 227-238, November, 1999.
- 98.149 PLOUMHANS P., G. WINCKELMANS, J.K. SALMON, "Vortex particles and tree codes: I. Flows with arbitrary corssing between solid boundaries and particle redistribution lattice; II. Vortex ring encountering a plane at an angle", *Third International Workshop on Vortex Flows and Related Numerical Methods*, Toulouse, France, Vol. 7, pp. 335-348 (www.emath.fr/Maths/Proc), 1999.
- 98.152 CARATI D., G. WINCKELMANS, H. JEANMART, "Exact expansions for filtered-scales modelling with a wide class of LES filters", *Proc. Isaac Newton Institute Symposium & Third ERCOFTAC Workshop on Direct and Large-Eddy Simulation*, Cambridge, U.K., Vol. 7, pp. 213-224, 1999.
- 99.08 DAVID B., G. BASTIN, "A maximum likelihood parameter estimation method for nonlinear dynamical systems", *proceedings IEEE Conference on Decision and Control (CDC99)*, Phoenix, USA, pp. 612-617, December, 1999.
- 99.09 SUYKENS J.A.K., L. LUKAS, P. VAN DOOREN, B. DE MOOR, J. VANDEWALLE, Least squares support vector machine classifiers : a large scale algorithm", *European Conference on Circuit Theory and Design (ECCTD'99)*, Stresa, Italy, pp. 839-842, August 29 - September 2, 1999.
- 99.10 BERNARD O. , D. DOCHAIN, C. BONVILLAIN, D. BENYAMINA, M. SCHAEGER, A. PAUSS, "Dynamical modelling of a waste stabilisation pond, based on a 2-Year intensive follow-up", *the 4th IAWQ Int. Conf. on Waste Stabilization Ponds*, Marrakech, Maroc, in press, 20-24 April, 1999.
- 99.11 BOMBOIS X., M. GEVERS, G. SCORLETTI, "Controller validation based on an identified model", *Proc. of the 38th IEEE Conference on Decision and Control (CDC99)*, Phoenix, USA, CD-Rom, pp. 2816-2821, December, 1999.
- 99.17 ZEALOUK L. , S. NIKOLOV, I. DOGHRI, "Numerical simulation of the micromechanics of semi-crystalline polymers in small strains", *Proceedings "European conference on Computational Mechanics" (ECCM'99)*, Munchen, Germany, CD-Rom paper L2, August 31- September 3, 1999.
- 99.18 ESPINOSA J.J., M. HADJILI, V. WERTZ, J. VANDEWALLE, "Predictive control using fuzzy models-Comparative Study, *ECC 99*, Karlshure, Germany, CD-Rom, paper F547 Session BA-7, July, 1999.
- 99.23 HADJILI M., V. WERTZ, "Generalized predictive control using Takagi-Sugeno fuzzy models", *1999 IEEE Int. Symp. on Intelligent Cont/ Int. Syst.& Semiotics, (ISIC/SA'S99)*, Boston, USA, 15-17 September, 1999.
- 99.24 ACHHAB M., M. LAABISSI, J. WINKIN, D. DOCHAIN, "State Trajectory Analysis of Plug Flow Non-isothermal Reactors Using a Nonlinear Model", *Proceedings of the 38th Conference on Decision and Control (CDC 99)*, Phoenix, USA, pp. 663-667, December, 1999.
- 99.27 GENIN Y., P. VAN DOOREN, "Stability radii of polynomial matrices", *Proc. of International Symposium on Computer Aided Control System Design* , Hawai, pp. 81-84, August 22-27, 1999.
- 99.30 WANG H.H., M. KRSTIC, G. BASTIN, "Optimum seeking by feedback for bioreactor models", *Proc. 14th IFAC World Congress*, Beijing, China, Vol. O, paper 7d-03-3, pp. 487-492, July, 1999.
- 99.31 SMETS I.Y., G. BASTIN, J.F. VAN IMPE, "Optimal adaptive control of fed-batch bioreactors for microbial growth processes with non-monotonic kinetics", *Proceedinsg IFAC ADCHEM 2000* , Pisa, Italy, pp. 479-484, June, 2000.
- 99.33 CALCEV G., R. GOREZ, V. WERTZ, "Passivity and Fuzzy Control of Singularly Perturbed Systems", *Proc. 38th IEEE Conference on Decision and Control (CDC'99)*, Phoenix, USA, pp. 4364-4367, December, 1999.
- 99.54 CODRONS B., P. BENDOTTI, C-M. FALINOWER, M. GEVERS, "A comparison Between Model Reduction and Controller Reduction : Application to a PWR Nuclear Plant", *38th IEEE Conference on Decision and Control (CDC99)*, Phoenix, USA, pp. 4625-4630, December, 1999.
- 99.68 GENIN Y., Y. NESTEROV, P. VAN DOOREN, "The analytic center of LMI'S and Riccati equations", *ECC'99*, Karlsruhe, Germany, CDRom paper F1018-5, July , 1999.

- 99.69 GENIN Y., Y. NESTEROV, P. VAN DOOREN, Positive transfer functions and convex optimization, *ECC99*, Karlsruhe, Germany, CD Rom paper F143, July, 1999.
- 99.85 FAVOREEL W., B. DE MOOR, M. GEVERS, "SPC: Subspace Predictive Control", *Proc. 14th IFAC World Congress*, Beijing, Vol. H; pp. 235-240, July, 1999.
- 99.86 ACHA V., M. MEURENS, H. NAVEAU, D. DOCHAIN, G. BASTIN, S.N. AGATHOS, "Model-Based Estimation of an Anaerobic Reductive Dechlorination Process Via an Attenuated Total Reflection-Fourier Transform Infrared Sensor", *Wat. Sci. Tech.*, Vol. 40, no 8, pp. 33-40, 1999.
- 99.87 RENO S., M. PERRIER, D. DOCHAIN, S. GENDRON, "Nonlinear Feedback Control of a PDE Model : Application to a Pulp Bleaching Tower", *AIChE Annual Meeting*, Dallas, poster 208r, November, 1999.
- 99.89 DONCKERS N., A. LENDASSE, V. WERTZ, M. VERLEYSSEN, "Extraction of intrinsic dimension using CCA - Application to blind sources separation", *Proceedings of ESANN'99, European Symposium on Artificial Neural Networks*, Brugges, Belgium, pp. 339-344, April, 1999.
- 99.103 LEONARD A., G. WINCKELMANS, "A tensor-diffusivity subgrid model for large eddy simulation", *Proc. Isaac Newton Institute Symposium & Third ERCOFTAC Workshop on Direct and Large-Eddy Simulation*, Cambridge, U.K., Vol. 7, pp. 147-162, 1999.
- 99.108 DUPRET F., "Numerical Modelling of Bulk Crystal Growth", *Proc. 1st Int. School on Crystal Growth and Advanced Materials*, Campiñas, SP, Brazil, R. Caram and S.L. Baldochi editors, pp. 67-78, July 1999.
- 99.109 MAL O., F. DUPRET, "Numerical Simulation of the Reactive and Liquid Moulding Processes", *Proc. 2nd ESAFORM conf. on Material Forming*, Guimarães, Portugal, April 1999, J.A. Covas editor, pp. 349-352.
- 99.110 JEGGY C., O. MAGOTTE, F. DUPRET, "Numerical Simulation of the Micro-Injection Moulding Process", *Proc. 2nd ESAFORM conf. on Material Forming*, Guimarães, Portugal, April 1999, J.A. Covas editor, pp. 117-120.

ACCEPTED CONFERENCE PAPERS

- 99.29 VAN DOOREN P., "Gramian Based Model Reduction of large-Scale Dynamical Systems", *Accepted in Numerical analysis 1999, DF Griffiths and G A Watson (Editors), Chapman & Hall/CRC Statistics and Mathematics (18th Biennial Conference on Numerical Analysis)*, 1999.
- 99.34 GENIN Y., Y. NESTEROV, P. VAN DOOREN, "Convex Optimization over Positive Polynomials", *Submitted to Fourteenth International Symposium on Mathematical theory of networks and systems - MTNS 2000*, Perpignan, France, June 2000, 1999.
- 99.35 GENIN Y., R. STEFAN, P. VAN DOOREN, "Real stability radii of polynomial matrices", *Submitted to Fourteenth International Symposium on Mathematical theory of networks and systems - MTNS 2000*, Perpignan, France, June 2000, 1999.
- 99.36 BOMBOIS X., M. GEVERS, G. SCORLETTI, B.D.O. ANDERSON, "Controller validation for stability and performance based on an uncertainty region designed from an identified model", *SYSID 2000*, 1999
- 99.37 DAVID B., G. BASTIN, "Parameter Estimation in Nonlinear Systems with Auto and Crosscorrelated Noise", *SYSID'2000*, Santa Barbara, USA, June, 2000, 1999
- 99.38 ACHHAB M. E., M. LAABISSI, J. WINKIN, D. DOCHAIN, "Analysis of a Nonlinear Dynamical Model of an Axial Dispersion Nonisothermal Reactor", *Accepted to MTNS 2000*, 1999.
- 99.49 GEVERS M., X. BOMBOIS, B. CODRONS, F. DE BRUYNE, G. SCORLETTI, "Model validation for robust control : experiment design issues", *Accepted for presentation at IFAC Symp. on System Identification (SYSID 2000)*, 1999.
- 99.51 GOMEZ G., G. CAMPION, M. GEVERS, P.Y. WILLEMS, "A case study of physical diagnosis for aircraft engines", *Proceedings American Control Conference (ACC 2000)*, Chicago, USA, 1999.
- 99.53 CODRONS B., B.D.O. ANDERSON, M. GEVERS, "Closed-loop identification with an unstable or nonminimum phase controller", *IFAC Symp. on System Identification SYSID 2000*, 1999.

- 99.55 GOREZ R., P. KLAN, "Nonmodel-based explicit design relations for PID controllers", *accepted for presentation at PID'00 IFAC Workshop*, Terrassa, Spain, 1999.
- 99.57 CHEN L., Y. HONTOIR, D. HYANG, J. ZHANG, A. JULIAN MORRIS, "Hybrid Modelling Combining First Principles with Black-Box Techniques for Reaction Systems : A case Study", *Submitted to SYSID 2000*, 1999.
- 99.65 IONESCU V., R. STEFAN, "Time varying signature condition : A Popov-Yakubovich based approach", *Submitted to MTNS'2000*, Perpignan, France, 1999.
- 99.66 CHEN L., Y. HONTOIR, J. ZHANG, G. BASTIN, "Model based control of a reactive distillation column", *Proceedings IFAC ADCHEM 2000*, Pisa, Italy, 1999.
- 99.67 RAO X., K.A. GALLIVAN, P. VAN DOOREN, "Stabilization of Large Scale Dynamical Systems", *MTNS 2000*, Perpignan, France, 1999.
- 99.73 STANCIULESCU, M. INSTALLE, "Robustness of solutions and risk assessment in multiobjective fuzzy linear programming problems", *Accepted for publication in Proc. 10th Workshop of the GOR-Working Group "Decision Theory and Practice"*, Frankfurt, March 2000, 1999.
- 99.74 STANCIULESCU, M. INSTALLE, "Robustness of solutions in multiobjective fuzzy problems under risk : some new results", *Submitted to the 17th European Conference on Operational Research, EURO XVII*, Budapest, July 2000, 1999.
- 99.81 LENDASSE A., J. LEE, V. WERTZ, M. VERLEYSEN, "Time Series Forecasting using CCA and Kohonen Maps - Application to Electricity Consumption", *Accepted to ESANN 2000 (European Symposium on Artificial Neural Network)*, , Bruges, Belgium, April 2000, 2000.
- 99.82 QUEINNEC I., D. DOCHAIN, "Modelling and simulation of the steady-state of secondary settlers in wastewater treatment plants", *Accepted to Watermatex 2000* , Gent, Belgium, September 2000, 1999.
- 99.83 GRÉGOIRE S., D. DOCHAIN, A. PAUSS, M. SCHAEGER, "Identification of a dynamical model of a waste stabilisation pond", *Accepted to Watermatex 2000*, Gent-Belgium, September 2000, 1999.
- 99.88 LEE J.A., A. LENDASSE, N. DONCKERS, M. VERLEYSEN, "A robust nonlinear projection method", *accepted to ESANN'2000 The European Symposium on Artificial Neural Networks* , Brugge, Belgium, April 2000, 1999.

INTERNAL REPORT

- 99.3 CAMPION G., M. GEVERS, G. GOMEZ, P.Y. WILLEMS, "Obidicote Work-Package 4" - Report 1 - A preliminary survey, *Rapport interne de recherche*, 1999.
- 99.14 GALLIVAN K., P. VAN DOOREN, "Recursive calculation of dominant singular subspaces", *Rapport de recherche*, 1999.
- 99.20 CAMPION G., M. GEVERS, G. GOMEZ, P.Y. WILLEMS, "Isolation Methodologies", *Obidicote Work-Package 4 - Report 2 -Projet Brite/euram BE 97-4077*, 1999.
- 99.21 CAMPION G., M. GEVERS, G. GOMEZ, P.Y. WILLEMS, "Simulations of diagnosis for the static engine model", *Obidicote Work-Package 4 - Report 3-Projet Brite/euram BE 97-4077*, 1999.
- 99.75 GOMEZ G., "Issues about on-line implementation of monitoring algorithms", *Technical note, OBIDICOTE WP4, Brite/Eurem Project BE 97-4077*, December, 1999.

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

(P. Van Dooren)

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

Complexity of algorithms

(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,

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

Optimization

(V. Blondel)

The aim of this course is to provide a general introduction to optimization. Linear optimization : simplex method, network flows problems, interior points methods. Discrete optimization : branch and bound. Nonlinear optimization : steepest descent, conjugate gradients, newton method, quasi newton methods (DFP, BFGS). The course is illustrated with several examples.

Graph theory

(V. Blondel, L. Wolsey)

Introduction to graph theory.

1.2 Mechanics

Physics I - Mechanics

(G. Campion, J. Govaerts)

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

Physics II - Mechanics

(G. Campion, 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 and Heat Transfer I

(G. Winckelmans, V. Legat)

Similarity and dimensional analysis (Vaschy-Buckingham, applications using dimensionless numbers). Continuum mechanics, global and local approaches, conservation equations, constitutive equations, Navier-Stokes. Thermal conduction. Elements of mass transfer. Solutions for incompressible flows: developed laminar viscous flows, head losses, heat transfer in developed laminar flows, establishment of viscous flows: entrance, establishment of heat transfer, laminar unsteady flows, creeping flows, lubrication, inviscid and irrotational flows (with use of a complex potential), Bernoulli, Joukowski profiles and Kutta-Joukowski condition, lift. Laminar boundary layers: Prandtl equations, Blasius solution, displacement thickness, momentum thickness, friction coefficient. Temperature profiles for unit Prandtl number (Crocco) and for general Prandtl number but with dissipation negligible, Reynolds analogy, von Karman integral equations (for momentum transfer and for heat transfer).

Fluid Mechanics and Heat Transfer II

(G. Winckelmans, M. Giot)

Conservation equations, constitutive equations and Navier-Stokes. Compressible flows: ideal gas, isentropic flow, Bernoulli, compressible flow at low Mach number compared to incompressible flow. isentropic flow in duct of variable cross-section (convergent, divergent, throat, subsonic flow, supersonic flow, maximum flow rate), normal shock and jump relations (Hugoniot), Adiabatic flow in uniform section but with friction (Fanno). Hydrodynamic stability: phenomenology and examples, perturbation of a laminar flow and linearization, linear instability of parallel viscous flows (Orr-Sommerfeld, with application to the boundary layer) and of inviscid flows (Rayleigh). Transition to turbulence: phenomenology of the steps to turbulence. Turbulence: characterization of the turbulent state. Statistical description and Reynolds stresses for turbulent momentum transfer and turbulent heat transfer. Reynolds-averaged Navier-Stokes (RANS) approach. Simple closure using turbulence viscosity models, with turbulent Prandtl number. Turbulent pipe flow and channel flow (mixing length: Prandtl, von Karman). Hydraulically smooth or rough surfaces. Universal velocity and temperature profiles (law of the wall, law of the wake). Coefficients for head losses and for heat transfer, Reynolds analogy. Turbulent boundary layers. Coefficients for friction and for heat transfer Practical formulas, including local head losses (expansion, contraction, bend, etc.) Natural convection: Boussinesq approximation, vertical plate, enclosures with horizontal or vertical thermal gradient. Phase changes: film condensation, boiling and the different modes, solidification, fusion. Heat exchangers: basic configurations, methods of computation, efficiency, exchanges of type liquid-liquid, gas-liquid, and others. Thermal radiation: physical laws, surface properties, exchange between black surfaces and real surfaces, radiation of gases.

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.

Control theory and optimization

(V. Wertz, M. Installé)

This course deals with the optimal control of or multicriteria optimization of complex systems.

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. Thyron)

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 course 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.

Advanced control design : theory and implementation

(M. Gevers, V.Wertz)

The aim of this course is to present advanced model based control design methods and to study implementations issues related to digital control. The course is highly based on real world case studies

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.

Process Control

(D. Dochain, G. Bastin)

This basic course in Automatic Control is the first course on Automatic Control for students in chemical engineering, biochemical engineering and electrochemical engineering (orientation Energy). In this course, the emphasis is put on the design controllers in the time domain (differential equations). The course is illustrated with examples taken from the process industry.

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 intedisciplinary 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. The following courses took place in 1999.

1. Spring session.

- **Control of Discrete Event Systems** (KULeuven, Heverlee)

Lecturers : Prof. R. Boel (SYSTEMS/RUG, Belgium)
Prof. S. Lafortune (University of Michigan, USA)
Prof. J. van Schuppen (C.W.I, The Netherlands)

Participants : 18

The participants came from the following institutions : ULB, KULeuven, RUG, ULg, UCL, VUB, Univ. of Dortmund, Univ. de Murcia (Spain)

- **Theory of Robot Control** (Louvain-la-Neuve)

Lecturers : Prof. G. Bastin (CESAME, UCL, Belgium)
Prof. G. Campion (CESAME, UCL, Belgium)

Participants : 20

The participants came from the following institutions : ULB, KULeuven, ULg, UCL, RUG, VUB, Ecole Royale Militaire, Philips Center for Manufacturing

2. Fall session.

- **Optimal estimation for model based robot control** (KULeuven, Heverlee)

Lecturers : Prof. H. Van Brussel, J. De Schutter, J. Swevers, H. Bruyninckx
(KULeuven, Belgium)

Participants : 16

The participants came from the following institutions : ULB, KULeuven, ULg, UCL, VUB, Ecole Royale Militaire.

- **Neural networks for system modeling and control**

Lecturers : Prof. Y. Moreau, J. Suykens, J. Vandewalle (KULeuven, Belgium)

Participants : 37

The participants came from the following institutions : ULB, KULeuven, UCL, VUB

2.2 Graduate course on Numerical Methods for Systems and Control

The course comprised a total of 15 hours of lectures, and consisted of one afternoon of three one-hour lectures, given on December 1998 and subsequently a sequence of several two-hour seminars given in February and March 1999.

Programme

- February 8, 1999
Bart de Moor (KUL/ESAT): *Subspace based methods for identification*
Paul Van Dooren (UCL): *Stability radii of dynamical systems*
- February 22, 1999
Marc Van Barel and Peter Kravanja (KUL/ESAT) : *Structured matrix problems*
- March 9, 1999
Volker Mehrmann (T.U. Chemnitz) : *DAE and ODE techniques*
- March 15, 1999
Dirk Roose and Tatyana Luzyanina (KUL/ESAT) : *Numerical methods for delay differential equations : time integration, stability analysis, computation of periodic solutions*
- March 23, 1999
Sabine Van Huffel (KUL/ESAT) : *Total least squares and identification*

2.3 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
- materials processing
- fluid mechanics
- 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.

The following courses took place in 1999 :

1. High-performance computing,
Lecturers : D. Roose, D. Vanderstraeten (KUL)
Participants : 28

2. Numerical simulations of shelf sea dynamics and estuarine circulation
Lecturer :J. Yu (KUL)
Participants : 3
3. Non-linear finite element analysis
Lecturer : S. Cescotto (UCL)
Participants : 18
4. Rheologically-complex materials
Lecturers : R. Keunings, V. Legat (UCL), J. Mewis, P. Moldenaers (KUL)
Participants : 15
5. Non-equilibrium thermodynamics for flowing systems
Lecturer : A. Beris (Cesame)
Participants : 20
6. Micromechanics of polycrystalline materials
Lecturer : P. van Houtte (KUL)
Participants : 8
7. Error control in finite element methods and mesh generation
Lecturers : P. Beckers, J.F. Debonnie (ULG), P. Bouillard (ULB)
Participants : 8

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

(M. Installé)

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.

2.7 Continuous education

In October 1999, M. Installé has designed and coordinated a 2-days intensive seminar on "Environmental Management Systems" for industries. 38 participants took part to this seminar.

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.
- **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.
- **European School of Rheology**, (KULeuven), 2h - R. Keunings.

5. Seminars at CESAME

Seminars

- Christina VERDE (University of Duisburg). "Location of multi-leaks in pipelines by dynamic observers", January 11, 1999.
- Guillermo GOMEZ (CESAME) "About systems MIMO control and fault diagnostic", January 12, 1999.
- Boumediene CHENTOUF (INRIA, Metz) "Sur la stabilité de l'échangeur thermique", January 19, 1999.
- Jacques LEFEVRE (Managing Director IDEA.SIM Ltd, London; professeur invité Ecole Centrale de Lille) "Modern businesses seen as evolving adaptive metabolic systems: a quasi bond graph and neuro-fuzzy approach", January 26, 1999.
- Graham BARNES (Institute of Neurology, Londres) "The remembered pursuit task: a tool for examining predictive oculomotor control", February 02, 1999
- André PREUMONT (ULB) "Les robots à pattes à l'ULB", February 12, 1999.
- Paul VAN DOOREN (CESAME) "Robustness and distance problems", February 16, 1999.
- Babatunde A. Ogunnaike (E. I. DuPont de Nemours and Company) "Statistical Appreciation of Industrial Chemical Process Control", February 18, 1999.
- Alain VANDE WOUVER (Fac. Polytechnique de Mons) "Modeling and optimization of a simulated moving bed in nonlinear equilibrium", February 23, 1999.
- Volker MEHRMANN (T.U. Chemnitz) "DAE and ODE techniques", March 9, 1999.
- Stuart TOWNLEY (University of Exeter) "Do convergent parameter estimation schemes lead generically, to stabilizing parameter estimates?", March 11, 1999.
- Benoit DAVID (CESAME) "Maximum likelihood parameter estimation in dynamical systems with correlated modeling uncertainty", March 16, 1999.
- Sabine VAN HUFFEL (KULeuven) "Total least squares and identification", March 23, 1999.
- Sophie de BROUWER (CESAME) "From quasiperiodicity to chaos in arterial vasomotion", March 30, 1999.
- Laurent FOULLOY (Université de Savoie, Annecy) "Capteurs flous et leurs applications", April 19, 1999.
- Joris DE SCHUTTER (KULeuven) "Using Kalman filters to estimate the geometry of the environment with a force controlled robot", April 20, 1999.
- Xavier BOMBOIS (CESAME) "Controller validation based on an uncertainty region designed from an identified model", April 27, 1999.
- Benoît CODRONS (CESAME) "Closed-loop model validation for control", May 4, 1999.
- Amaury LENDASSE (CESAME) "Time-series prediction : a nonlinear approach", May 11, 1999.
- Svetoslav NIKOLOV (CESAME) "Micro/Macro Constitutive Modeling for the Small-Deformation Behavior of Semi-crystalline Polymers", May 11, 1999.
- Philippe BOGAERTS (ULB) "Mathematical modelling for simulation and state observation of bio-processes", May 18, 1999.
- Raymond GOREZ (CESAME) "Revisiting some classics in control theory", May 25, 1999.
- Charles L. TUCKER III (University of Illinois) "Fiber orientation predictions in 2-D and 3-D injection molded features", May 25, 1999.
- Charles L. TUCKER III (University of Illinois) "Microstructural models for liquid-liquid mixing", May 26, 1999.
- Edmond JONCKHEERE (University of Southern California) "What goes wrong from 3 to 4 blocks?", May 27, 1999.
- Cristina STANCIULESCU (CESAME) "Multicriteria decision-making for agro-ecosystems dynamic planning using fuzzy concepts", June 1, 1999

- B.D.O. ANDERSON (Australian National University) "Fundamental Problems In Adaptive Control", June 8, 1999.
- Emmanuel Leriche (Fluid Mechanics Laboratory, EPFL, Lausanne) "Direct Numerical Simulation of a Lid-Driven Cavity Flow by a Chebyshev Spectral Method", June 14, 1999.
- Georges BASTIN (CESAME) "Lyapunov control design for irrigation canals described by (Saint-Venant) partial differential equations", June 15, 1999.
- Mohamed HADJILI (CESAME) "Modélisation et commande par logique floue", June 22, 1999.
- Miroslav GRMELA (Ecole Polytechnique de Montréal) "On Multilevel Descriptions and Closures in Rheological Modeling", June 29, 1999
- Elarbi ACHHAB (El Jadida/CESAME) "Introduction à l'analyse des systèmes à paramètres distribués", September 14, 1999.
- Louri ORLOV (visiting professor at CICESE, Research Center, Mexico) "Discontinuous model reference adaptive control of distributed parameter systems", September 21, 1999.
- Daniel GUITTON (Montreal Neurological Institute McGill University) "The neural control of fixation", September 28, 1999.
- Benoît CODRONS (CESAME) "Closed-loop identification with an unstable or nonminimum phase controller", October 5, 1999.
- Michel DEWAN (CESAME) "Aperçu des principes de programmation temps réel en Labview, exemple : programme de pilotage du système à trois réservoirs", October 12, 1999.
- Study day of IUAP 4/02 network, in honour of professor Raymond Gorez. Guest speaker : V. Kucera, October 2, 1999.
- Hugues MOUNIER (Institut d'électronique fondamentale. Université Paris sud) "Contrôle de congestion dans les réseaux haut débit : une approche par suivi de trajectoires", October 19, 1999.
- Jérôme HARMAND (LBE-INRA, Narbonne) "Observateurs robustes non linéaires: application aux procédés biologiques de dépollution", October 26, 1999.
- Xavier BOMBOIS (CESAME) "Controller validation for stability and for performance based on an uncertainty region designed from an identified model", November 2, 1999.
- Libei CHEN (SOLVAY/CESAME) "Modélisation et contrôle d'une colonne de distillation réactive", November 9, 1999.
- Pierre ROUCHON (Ecole des Mines, Fontainebleau) "Dynamique et commande d'oscillateurs (pendule, chaîne pesante, oscillateur quantique à deux états)", November 16, 1999.
- Isabelle QUEINNEC (LAAS-CNRS, Toulouse) "Commande robuste H2 sous contraintes", November 23, 1999.
- Joseph WINKIN (FNNDP, Namur) "Spectral factorization by symmetric extraction for distributed parameter systems", November 30, 1999.
- Guillermo GOMEZ (CESAME) "Fault diagnosis in aircraft engines - a case study", December 7, 1999.
- Anthony BERIS (Univ. Delaware) "Direct numerical simulation of polymer-induced drag reduction in turbulent channel flows", December 9, 1999.

6. National or international contacts

1 Visits received

11/01/99	15/01/99	VERDE Cr.	Univ. of Duisburg/Nat.Univ. Mexico, Mexique
19/01/99		CHENTOUF B.	INRIA/Metz, France
20/01/99	21/01/99	MAFFETONE P. L.	University of Naples, Italy
26/01/99		LEFÈVRE J.	IDEA.SIM Ltd, London, UK/Ecole Centrale de Lille, France
27/01/99		VIOLINI G.	Directeur progr. UNESCO
02/02/99	04/02/99	BARNES G.	Institute of Neurology, Londres, UK
12/02/99		PREUMONT A.	Université Libre de Bruxelles, Belgium
18/02/99		OGUNNAIKE B.A	DuPont de Nemours & Company, France
23/02/99		VANDE WOUWER A.	Facultés Polytechnique de Mons, Belgium
08/03/99	12/03/99	TOWNLEY S.	University of Exeter, UK
08/03/99	12/03/99	MOSS Thuto	University of Exeter, UK
19/04/99		FOULLOY L.	Université de Savoie, Annecy, France
20/04/99		DE SCHUTTER R J.	KULeuven, Belgium
22/04/99	23/04/99	LEONARD A.	Graduate Aeronautical Laboratories, California Institute of Technology
14/05/99	22/05/99	POSTOLACHE C.	Université de Bucharest, Roumanie
17/05/99	31/05/99	DE BRUYNE F.	Australian National University, Canberra, Australia
25/05/99	26/05/99	TUCKER Ch.	University of Illinois, USA
25/05/99	11/06/99	ANDERSON B.D.O.	Australian National University, Canberra, Australia
25/05/99	04/06/99	VERBIER Ch.	ENSIEG/INPG de Grenoble, France
27/05/99		JONCKHEERE E.	University of Southern California, USA
31/05/99	4/06/99	QUEINNEC Isabelle	LAAS/CNRS de Toulouse, France
02/06/99	04/06/99	SORENSEN D.	Rice University, USA
02/06/99	04/06/99	ANTOULAS Th.	Rice University, USA
29/06/99		MIROSLAV Grmela	Ecole Polytechnique, Montreal, Canada
05/07/99	06/07/99	GIUSEPPE M. and GIOVANNI I.	University of Naples, Italy
12/07/99	16/07/99	MISSAL M.	Smith/Kettlewell Eye Research Institute, USA
24/08/99	31/08/99	ILLCHMANN A.	Universidade do Porto, Portugal
31/08/99	08/09/99	CZECZOT J.	Inst. Of Aut. Control of Gliwice, Poland
13/09/99	14/09/99	HINCH John	Cambridge University, UK
28/09/99	01/10/99	GUITTON D.	McGill University, Montréal, Canada
29/09/99		WALTERS K.	University of Wales, Aberystwyth, UK
29/09/99		HINCH J.	Cambridge University, UK
29/09/99		HASSAGER Ole	Danish Technical University, Lyngby

29/09/99		LASO M.	Madrid Technical University, Spain
29/09/99		VAN DEN BRULE B.	Technical University Delft, The Netherlands
07/10/99		GRODENT M.	Techspace Aéro, Liège, Belgium
15/10/99		KEVICZKY L.	Académie des Sciences de Hongrie, Hungary
19/10/99		MOUNIER H.	Université de Paris Sud, Paris, France
21/10/99	24/10/99	KUCERA V.	Czech Technical University, Prague, Tchequie
25/10/99	29/10/99	HARMAND J.	LBE/INRA, Narbonne, France
25/10/99	29/10/99	KLAN P.	Institute of Computer Science, Prague, Tchequie
16/11/99		ROUCHON P.	Ecoles des Mines, Fontainebleau, France
19/11/99		SCORLETTI Gérard	LAP ISMRA, France
22/11/99	26/11/99	QUEINNEC I.	LAAS/CNRS, Toulouse, France
24/11/99		DARLOT C.	ENST/Paris, France
24/11/99		ELISSON D.	INSERM, Lyon, France
24/11/99		WINKIN J.	FNDP, Namur, Belgium
03/12/99		NICHITIU C.	ENS, Lyon, France
08/12/99	09/12/99	MANTACI S.	Université Denis Diderot, Paris, France

2 Scientific missions

Ansay Pierre

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
02/06/99 04/06/99 American Control Conference, ACC'99, San Diego, USA
30/11/99 05/12/99 Visit to Wacker in the framework of a joint research project on the control of crystal growth processes

Bastin Georges

08/01/99 Working group in automatic control at L'E.N.S. Cachan (Paris), France
13/01/99 Doctoral thesis committee of M. de Mathelin at Université de Strasbourg, France
14/01/99 Doctoral thesis committee of Q. Zhang at IRISA (Rennes), France
22/02/99 26/02/99 Visit at the LAG of Grenoble, France to give a DEA course
03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
15/03/99 16/03/99 Nonlinear Control Network workshop : "Stability and Stabilization", Gent, Belgium
26/04/99 28/04/99 Visit at the University of Exeter (UK), Department of Mathematics
06/05/99 09/05/99 Visit at the University Cadi Ayyad of Marrakech (Maroc) to give a course on "Identification et commande prédictive des procédés industriels"
01/06/99 06/06/99 Course in the framework of CIUF/CUD at Ougadougou (Burkina Faso)
08/06/99 09/06/99 Visit at 'Ecole des Mines de Paris'
24/06/99 Visit at Danone (Paris), France to give a seminar
05/07/99 09/07/99 Participation at the 14th IFAC World Congress, Beijing, China
27/09/99 29/09/99 ERNSI Workshop System Identification, La Villa Sainte-Camille, Théoule (Cannes) France
30/09/99 01/10/99 Visit at l'INRA, Sophia Antipolis, France
06/12/99 12/12/99 38th Conference on Decision and Control, CDC 99, Phoenix (USA)
10/12/99 14/12/99 Visit at the University of Brooklyn (USA)

Benayad Abdou

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
31/08/99 03/09/99 Participation at the 5th European Control Conference(ECC), Karlsruhe (Germany).

Blondel Vincent

18/01/99 19/01/99 PhD thesis committee meeting of Olivier Bournez and scientific visit to Dr P. Koiran, Ecole Nationale Supérieure, Lyon, France.
29/03/99 31/03/99 Participant in a conference "Tropical days and alapedes meeting", Ecole Nationale Supérieure, Paris, France.
01/04/99 Presentation of a seminar (invited by Dr.J.P. Delahaye). Title of the presentation : Complexity and decidability of problems in systems and control. University of Lille, Lille, France.
16/04/99 18/04/99 Participant in a conference. Belgian Royal Academy of Sciences, Brussels, Belgium.
18/04/99 15/05/99 Invited professor, University of Paris VII, France
08/05/99 Visit to Prof. F. Bacelli, Ecole Normale Supérieure Paris, France.
17/05/99 Visit to Prof. R. Brockett, Harvard University, Cambridge, USA.

18/05/99		Visit to Prof. J. Tsitsiklis, Massachusetts Institute of Technology, Cambridge, USA.
28/06/99		PhD thesis committee meeting of Ines Kliman and scientific visit, Université de Lyon 1, Lyon, France.
06/07/99	09/07/99	4th International Conference on Developments in Language Theory, RWTH-Aachen, Germany.
30/09/99	01/10/99	Workshop at the University of Delft (The Netherlands) and participation at a meeting of the european committee TMR Alapedes on discrete event systems.
22/10/99		Participant in a ICCo/IUAP Study Day
27/10/99	29/10/99	Participant in a conference on cellular automata, Ecole Nationale Supérieure, Lyon, France
08/12/99	12/12/99	Scientific visit from Dr. Sabrina Mantaci (University of Paris VII, France).

Bombois Xavier

03/03/99	05/03/99	18th Benelux Meeting on Systems and Control, Houthalen, Belgium
10/03/99	24/03/99	Visit at UFR de Caen, France, collaboration with Gérard Scorletti
21/06/99	24/06/99	Dutch Summer School on Identification for Control, Veldhoven
07/07/99	21/07/99	Visit at the LAP, Caen (France), collaboration with Gérard Scorletti
31/08/99	03/09/99	5th European Control Conference(ECC), Karlsruhe (Germany)
27/09/99	29/09/99	ERNSI Workshop System Identification, La Villa Sainte-Camille, Théoule (Cannes) France
06/12/99	12/12/99	38th Conference on Decision and Control (CDC 99), Phoenix (USA)

Campion Guy

04/02/99	05/02/99	Meeting Brite Euram (Projet OBIDICOTE), Naples, Italy
03/03/99	05/03/99	18th Benelux Meeting on Systems and Control, Houthalen, Belgium
16/09/99	17/09/99	Progress meeting of the Brite Euram OBIDICOTE, MTU, Munich, Germany.

Chen Libei

18/01/99	20/01/99	Meeting in the framework of the project MONNET, at the University of Valladolid, Spain
22/02/99		Visit to Solvay, Rheinberg (Allemagne) in the framework of the project MONNET
11/03/99	12/03/99	idem
22/03/99	25/03/99	idem
22/04/99	23/04/99	idem
06/05/99	07/05/99	idem
07/06/99	11/06/99	idem
01/07/99	02/07/99	Visit at the Société Bertin Technologies, Tarnos, France, in the framework of the project MONNET
05/07/99	09/07/99	Participation at the 14th IFAC World Congress IFAC, Beijing, Chine
26/08/99		Visit to Solvay, Rheinberg (Allemagne) to finalize the project MONNET

Codrons Benoît

03/03/99	05/03/99	18th Benelux Meeting on Systems and Control, Houthalen, Belgium
02/06/99	04/06/99	American Control Conference, ACC'99, San Diego, Californie, USA
27/09/99	29/09/99	ERNSI Workshop System Identification, La Villa Sainte-Camille, Théoule (Cannes) France
06/12/99	12/12/99	38th Conference on Decision and Control (CDC 99), Phoenix (USA)

Coimbra Alexandre

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium

David Benoît

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 27/09/99 29/09/99 ERNSI Workshop System Identification, La Villa Sainte-Camille, Théoule (Cannes) France

de Brouwer Sophie

01/06/99 30/06/99 Imperial College, London, UK : collaboration with Professor Graham Barnes
 03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 05/09/99 11/09/99 Imperial College, London, UK : collaboration with Professor Graham Barnes

Dochain Denis

13/01/99 Doctoral thesis committee of Laurent Lefèvre at Lille, France
 19/01/99 Meeting in Paris, France, to prepare a European project
 03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 10/03/99 12/03/99 Meeting COST 624 in Grenoble, France
 19/04/99 26/04/99 Visit at the University Cadi Ayyad, Marrackech, Maroc, and collaboration with Prof. A. Benhammou in the framework of the cooperation agreement between Marocco and the CGRI
 17/05/99 24/05/99 Visit at LAAS, Toulouse, France and collaboration with Prof. J.P. Babary in the framework of the cooperation between CNRS/FNRS
 15/06/99 18/06/99 Visit at LBE, Narbonne and collaboration with J.P. Steyer.
 15/06/99 18/06/99 Meeting of the European Project AMOCO, Perpignan, France
 05/07/99 09/07/99 14th IFAC World Congress IFAC, Beijing, Chine
 20/07/99 23/07/99 Meeting of the European Project AMOCO, Narbonne (LBE-INRA) France
 11/09/99 15/09/99 Meeting of the project AMOCO, Pontevedra, Spain
 01/12/99 Doctoral thesis committee at the LAG, Grenoble, France
 14/12/99 Doctoral thesis committee of Zakaria Hadj-Sadok at Sohia-Antipolis, France
 15/12/99 Doctoral thesis committee of Tony Genovesi at Narbonne, France
 16/12/99 17/12/99 Meeting of the European Project AMOCO.

Doghri Issam

23/04/99 24/04/99 Visit to London for a meeting of the Management Committee of COST action P3 : "Simulation of physical phenomena in technological applications" and a meeting of the Working Group on "Micromechanics simulation".
 31/08/99 03/09/99 In Munich for the ECCM '99 Conference (European Conference on Computational Mechanics) : presentation of a communication whose co-authors are L. Zealouk and S. Nikolov.
 9/09/99 11/09/99 In Helsinki for the workshop on "Simulation of physical phenomena in technological applications" : presentation of a communication whose co-authors are S. Nikolov and L. Zealouk followed by a meeting of the Management Committee of COST action P3.
 21/12/99 23/12/99 At Stanford University for a seminar and work sessions with Prof. Tom Hughes, Professor at the Mechanics and Computation Division.

Dupret François

08/01/99	16/01/99	Visit to Japan namely to Shin-Etsu (SEH), Super-Silicon (SSI), Mitsubishi Materials (MM), Komat'su (KOM), Nippon Electric Corporation (NEC, Mitsubishi Corporation (MC), Japan Inter Processing Service (JIP) for presentations, scientific discussions and contractual discussions.
09/01/99		preliminary defense of Oliver Mal's thesis (as promotor).
21/01/99	22/01/99	BRITE meeting (mid-term revue) with the following participants: Oxley Division, Philips Petroleum, Institut Mikro Mechanik Mainz (IMM), Eas Dev. and UCL.
04/02/99		Visit to Shell in Louvain-la-Neuve for final discussions on the "Stretch Blow Molding of PET" project;
01/03/99		ESP4 Course and exam at Oyonnax, France. First meeting of the Sous-commission "Mécanique et Matériaux" Preliminary defense of Abdellziz Amine's thesis (as member of the Jury).
08/03/99		Public Defense of Olivier Mal's thesis (as promotor). Public defense of Abdellaziz Amine's thesis (UMH) as member of the Jury
22/04/99		Visit to Shell in Louvain-la-Neuve "Stretch Blow Molding of PET" project
27/04/99		Commission "Solides" (I. Doghri)
11/05/99	12/05/99	Received the visit of M. Gahmousse (University of Alger) for discussions on "Pédagogie de Milieux Continus et Mécanique des Fluides"
20/05/99	26/05/99	Visit to Shell in Louvain-la-Neuve "Stretch Blow Molding of PET" project
25/05/99		Received the visit of O. Verhoyen (discussions on the project FIRST)
28/05/99		COMUT meeting
19/07/99	23/07/99	Course given at the "International School on Crystal Growth and Advanced Materials" in Campinas, Brazil. Title of the course: "Numerical modeling on bulk crystal growth"
06/08/99		Received the visit of D.P. Hurley (Magnetic Solutions, Ltd) and J.M.D. Coey (Trinity College, Department of Physics) for scientific discussions (magnetic fields in crystal growth)
10/08/99		BRITE project meeting (discussions in view of a prolongation)
03/09/99		Defense of Philippe Geuzaine's thesis at the Université de Liège (as member of the Jury)

Gevers Michel

19/02/99		Doctoral thesis committee at the Katholieke Universiteit Leuven
12/04/99	14/04/99	Visit at the University of Iowa, and collaboration with Prof Soura Dasgupta
05/05/99		Meeting of the 'Commission Electricité et Mécanique appliquée du FWO', Brussel
18/05/99		Meeting of the scientific committee of the 'Laboratoire CNRS "Heuristique et Diagnostic des Systèmes Complexes", Compiègne, France
21/06/99	24/06/99	Dutch Summer School on Identification for Control, Veldhoven
27/08/99	28/08/99	Astrom Symposium on Control, Lund, Sweden
31/08/99	03/09/99	5th European Control Conference(ECC), Karlsruhe (Germany)
27/09/99	29/09/99	ERNSI Workshop System Identification, la Villa Sainte-Camille, Théoule (Cannes) France
06/11/99	07/11/99	Meeting of the Executive Committee of the IEEE Control Systems Society, Detroit (USA)
21/11/99	22/11/99	Visit at Lund University, Sweden, and collaboration with K.J. Aström and B. Wittenmark
24/11/99	25/11/99	Visit at KTH (Stockholm), and collaboration with H. Hjalmarsson
06/12/99	12/06/99	38th Conference on Decision and Control (CDC 99), Phoenix (USA)

Gomez Guillermo

04/02/99 05/02/99 Meeting of the Brite Euram (Projet OBIDICOTE), Naples, Italy
16/09/99 17/09/99 Progress meeting of the Brite Euram (Project OBIDICOTE), MTU, Munich

Gorez Raymond

22/03/99 Doctoral thesis committee of Anne Bajart, Université de Liège, Belgium
05/05/99 Meeting of the 'Commission Electricité et Mécanique appliquée du FWO',
Brussel
11/07/99 Doctoral thesis committee of Mohamed Chaoui, Université de Liège, Belgium
31/08/99 03/09/99 5th European Control Conference (ECC), Karlsruhe (Germany)

Grognard Frédéric

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
15/03/99 16/03/99 Nonlinear Control Network workshop : "Stability and Stabilization", Gent,
Belgium
04/05/99 05/05/99 Participation in the course "Optimization algorithms on manifolds and their
corresponding flows" by R. Mahony, University of Liège, Belgium.

Hadjili Mohamed

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium

Henry Philippe

01/03/99 05/03/99 Visit to Wacker in the framework of a joint research project on the control of
crystal growth processes
21/04/99 26/04/99 idem
25/05/99 29/09/99 idem

Installé Michel

07/01/99 Plenary session of "Conseil Wallon de l'Environnement pour le Développement
Durable", Namur, Belgium
21/01/99 Workshop of "Conseil Wallon de l'Environnement pour le Développement
Durable", Namur, Belgium
04/02/99 idem
18/02/99 19/02/99 Workshop on "Ingénierie Environnementale" in the framework of the pro-
gramme CLUSTER.
04/03/99 Plenary session of "Conseil Wallon de l'Environnement pour le Développement
Durable", Liège, Belgium
14/03/99 17/03/99 Ecole des mines de Paris, participation at a course entitled "Sustainable Man-
agement and Technology" organized in the framework of the european pro-
gramme ATHENS.
01/04/99 Plenary session of "Conseil Wallon de l'Environnement pour le Développement
Durable", Liège, Belgium
21/04/99 Meeting of the "Conseil Wallon de l'Environnement pour le Développement
Durable" (CWEDD) and the Conseil Economique et Social de la Région Wal-
lonne (CESRW)

06/05/99	19/05/99	Meeting of the the “Conseil Wallon de l’Environnement pour le Développement Durable” (CWEDD)
25/05/99	31/05/99	Meeting of the the “Conseil Wallon de l’Environnement pour le Développement Durable” (CWEDD)
21/06/99		idem
01/07/99		idem
22/09/99	23/09/99	Workshop on “Environmental Life-cycle Engineering towards 2000”, Fontainebleau, France
23/09/99	26/09/99	Conference on “Industrial Ecology and Sustainability”, Troyes, France
04/11/99		Meeting of the “Conseil Wallon de l’Environnement pour le Développement Durable” (CWEDD)
09/11/99	12/11/99	International Conference on Environmental Training in Engineering Education, Tampere.

Jeanmart Herve

10/11/99		Participation in the meeting of the Belgian LES research group, organised by Prof. Martine Baelmans at KUL, and presentation of a seminar.
21/11/99	23/11/99	Participation in the 52nd Annual Meeting of the Division of Fluid Dynamics, American Physical Society, New Orleans, Louisiana, and presentation of a communication: “Large-eddy simulation in the vorticity-velocity formulation using a new mixed model and explicit filtering”.

Jeggy Cécile

13/04/99	17/04/99	In Guinares (Portugal) at the ESAFORM Conference : presentation of a poster on: ”Numerical simulation of micro-injection molding”.
----------	----------	--

Keunings Roland

12/01/99	13/01/99	Dept. Chemical Engng., Univ. of Naples, Italy. Seminar and participation to Ph.D. jury of Massimiliano Grosso.
14/03/99	19/03/99	Invited Lecture, Gordon Conference on Computer Aided Engineering in Polymer Processing, Ventura, CA, USA.
07/04/99	08/04/99	Communication, BRITE-EURAM Polymer Workshop, Nice, France.
20/05/99	21/05/99	Communication, meeting of TMR ”Dynamics of Polymeric Liquids”, Aix-les-Bains, France.
04/06/99	05/06/99	Seminar, Dept. Chem. Engng., Mc Gill University, Montreal, Canada.
6-6-99	8-6-99	Invited Lecture, Int. Symp. Dedicated to Prof. M.M. Denn, Berkeley, CA, USA.
10-6-99	11-6-99	Communication, BRITE-EURAM MPFLOW Meeting, Zurich, Switzerland.
25-8-99	28-8-99	Communication, Int. Workshop on Numerical Methods in Non-Newtonian Flows, Maastricht, The Netherlands.
07/09/99	08/09/99	Plenary Lecture, ISCFD, Bremen, Germany.
02/11/99	03/11/99	Communication, meeting of TMR ”Dynamics of Polymeric Liquids”, Brussels, Belgium
14/11/99	17/11/99	Invited Lecture, Int. Symp. Dedicated to Prof. D.V. Boger, Melbourne, Australia
03/12/99		Seminar, Ecole Nationale des Ponts et Chaussees, Paris, France

Lendasse Amaury

11/01/99 15/01/99 ICA'99 "Independent Component Analysis and Blind Signal Separation", CAES, CNRS, Aussois, France.
 03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 20/04/99 23/04/99 "European symposium on artificial neural networks", Bruges, Belgium
 21/06/99 24/06/99 Dutch Summer School on Identification for Control, Veldhoven
 08/07/99 Visit at the Delft University and collaboration with Dr. M. Verhaegen

Lefevre Laurent

09/06/99 10/06/99 Participation at two study days on "Systèmes à dérivation non entière" at the LAP, Bordeaux, France

Lefevre Philippe

08/07/99 Doctoral thesis committee, Ecole Nationale Supérieure des Télécommunications, Paris.

Legat Vincent

17/03/99 18/03/99 In Tampere (Finland) for a BRITE/EURAM meeting of the MENUSIM thematic network.
 26/03/99 At the CERTECH for a working session meeting on industrial collaboration between Usinor/Cockerill and CESAME.
 27/05/99 Visit with T. Avalosse (Polyflow, S.A.) as members of a commission of experts for the BRITE/EURAM projects, to the Laboratoire de recherche Michelin and the Laboratoire de Physique de la matière condensée (Collège de France).
 22/06/99 25/06/99 In Uxbridge (London, UK) for the MAFELAP'99 (10th International Conference on the Mathematics of Finite Elements and Applications) : presentation of a conference entitled: "Hp-adaptive FEM for viscoelastic flow calculations".
 22/10/99 23/10/99 In Leuven for a meeting of the " Polyflow users group " .

Magotte Olivier

13/04/99 17/04/99 Presentation of a poster on "Numerical simulation of micro-injection molding", ESAFORM Conference, Guinares (Portugal)

Mal Olivier

13/04/99 17/04/99 In Guinares (Portugal) for the ESAFORM Conference and presentation of a communication entitled: " Numerical simulation of the reactive and liquid processes " .

Motte Isabelle

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 04/05/99 05/05/99 Participation in the course "Optimization algorithms on manifolds and their corresponding flows" by R. Mahony, Institut Montefiore de Liège, Belgium
 17/06/99 Study day in Namur, and collaboration with Prof Stepanov

Pengov Marco

09/02/99 12/02/99 Visit at Sophia Antipolis in the framework of the project AMOCO.
 15/02/99 19/02/99 Visit at Narbonne, France
 03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 15/03/99 16/03/99 Participation in the Nonlinear Control Network workshop : "Stability and Stabilization", Gand, Belgium
 17/05/99 21/05/99 Visit at INRIA, Metz, and collaboration with J.C. Vivalda
 02/06/99 04/06/99 American Control Conference (ACC'99), San Diego, Californie
 21/06/99 22/06/99 Meeting of the european project AMOCO, Perpignan, France
 16/08/99 19/08/99 Visit at INRA/LBE, Narbonne, France, in the framework of the project AMOCO

Ploumhans Paul

21/08/99 05/09/99 Visit to the California Institute of technology, group of Prof. A. Leonard, in the framework of our collaboration in the lagrangian simulation, using vortex particle methods, of 3-D bluff body flows.

Sepulchre Rodolphe

28/01/99 29/01/99 Visit at the CNRS Lab Heudyasic, Université de Compiègne and presentation of a seminar
 08/02/99 12/02/99 Visit at the CAS, Ecole des Mines de Paris and collaboration with L. Praly
 10/02/99 Visit at the CNRS Lab LSS, Supelec, Paris and presentation of a seminar
 03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen and presentation of a minicourse on "Nonlinear Control through case studies"
 15/03/99 16/03/99 EC/TMR Nonlinear Control Network Workshop "Stability and Stabilization", and presentation of a communication, Ghent, Belgium
 22/03/99 26/03/99 Visit at Lund Institute of Technology, Sweden. Presentation of a seminar and committe member for a doctoral thesis entitled "Piecewise linear control systems"
 11/05/99 12/05/99 Visit at Ecole des Mines de Paris and collaboration with Pierre Rouchon
 07/06/99 Visit at Ghent University. Committee member for a doctoral thesis.
 14/06/99 21/06/99 Visit at Massachussets Institute of Technology. Presentation of a seminar and collaboration with Alexander Megretski.
 02/09/99 04/09/99 4th European Control Conference 99 and EUCA Council Meeting, Karlsruhe, Germany.
 06/12/99 09/12/99 38th IEEE Conference on Control and Decision, Phoenix, Arizona and presentation of a workshop entitled "Constructive Nonlinear Control"
 09/12/99 12/12/99 Visit at National Proton Therapy Center, Boston, Massachussets.

Stanciulescu Cristina

03/03/99 05/03/99 18th Benelux Meeting on Systems and Control, Houthalen, Belgium
 18/03/99 19/03/99 Participation at the "Multicriteria aid for decisions", Milan, Italy
 28/09/99 02/10/99 Participation at the "Multicriteria aid for decisions", Cerisy-la-Salle (France)
 21/10/99 22/10/99 Participation at LFA'99, University of Valenciennes.

Stefan Radu

17/05/99 19/05/99 Workshop LMI/ILAC, Compiègne France
 04/10/99 05/10/99 Visit at the 'Université de Technologies de Compiègne', France, and collaboration with Prof. V. Rasvan.

Thirifay François

- 22/03/99 26/03/99 Participation in the Lecture Series on "Introduction to turbulent combustion", von Karman Institute.
- 21/11/99 23/11/99 Participation in the 52nd Annual Meeting of the Division of Fluid Dynamics, American Physical Society, New Orleans, Louisiana, and presentation of a communication: "Application of a vortex method with non-uniform resolution to the 2-D space-developing jet".

Van Den Bogaert Nathalie

- 23/04/99 At CEA/CEREM in Grenoble to participate, as member of the jury, to the defense of Sylvain Gondet's thesis.

Van Dooren Paul

- 31/05/99 01/06/99 Meeting of the project Brite Euram, NICONET
- 12/06/99 21/06/99 Householder Symposium, Vancouver, Canada
- 28/06/99 07/07/99 18th Biennial Conference on Numerical Analysis, Dundee (Scotland)
- 19/07/99 22/07/99 8th Conference of the International Linear Algebra Society (ILAS), Barcelone, Spain
- 25/07/99 28/07/99 FoCM'99, Oxford, UK
- 01/08/99 21/08/99 Visit at the Florida State University and collaboration with Prof. K. Gallivan.
- 22/08/99 27/08/99 IEEE International Symposium on Computer-Aided Control Systems Design, Hawai
- 2/12/99 5/12/99 Meeting of the project NICONET, Paris, France
- 10/12/99 12/12/99 Workshop "Approximation and Robustness in Systems and Control" Bremen University, Bremen, Germany

Wapperom Peter

- 20/05/99 21/05/99 Meeting of the TMR network "Dynamics of polymeric liquids" and presentation of a communication, Aix-les-Bains (France).

Wertz Vincent

- 07/01/99 Doctoral thesis committee of J. Chebassier, LAG, Grenoble, France
- 14/01/99 16/01/99 Visit at Caen University
- 12/02/99 Doctoral thesis committee of Jairo Espinosa, KULeuven, Belgium
- 03/03/99 05/03/99 Visit to Wacker in the framework of a joint research project on the control of crystal growth processes
- 29/04/99 Meeting at Air Liquide, Paris, France
- 05/05/99 09/05/99 Visit at University Cadi Ayyad of Marrakech (Maroc) to give a course on "Identification et commande prédictive des procédés industriels"
- 17/05/99 Meeting at Air Liquide, Paris, France
- 27/06/99 28/06/99 Meeting at El Jadida, Maroco, in the framework of the cooperation agreement between Maroco and the CIUF
- 06/07/99 12/07/99 International Conference on problem based learning", Montréal, Canada
- 13/09/99 15/09/99 Meeting on "Problem Based Learning" at the University of Delaware, USA
- 15/09/99 17/09/99 Symposium on Intelligent Control, Boston, USA.
- 22/09/99 Participation "La cinquième journée de l'Association Internationale de Pédagogie Universitaire (AIPU)" de la Communauté française, Brussel, Belgium
- 20/10/99 Visit and meeting at "Les cristalleries de Champagne", Bayel, France
- 30/11/99 02/12/99 Visit to Wacker in the framework of a joint research project on the control of crystal growth processes

Willems Pierre-Yves

21/04/99 Meeting at Daimler Aerospace, Brême, Germany
11/12/99 12/12/99 Visit at "ENSAM", Paris, France
18/12/99 19/12/99 idem

Winckelmans Gregoire

23/03/99 25/03/99 Participation in the Wake Vortex Meeting at NASA Langley, USA, in the framework of the collaboration between the US team and the Canadian-Russian-Belgian (CRB) team in developing an aircraft wake vortex spacing system (AVOSS) which could use the predictor under development by the CRB team: the vortex forecast system (VFS) based on the method of discrete vortices.

26/03/99 Participation in the Wake Vortex Meeting at Transport Canada, Ottawa, Canada, in the framework of the VFS project.

12/05/99 14/05/99 Participation au "Isaac Newton Institute Symposium and Third ERCOFTAC Workshop on Direct and Large-Eddy Simulation", Cambridge, U. K. (co-author of two papers).

27/05/99 Participation in GRASCOM meeting at KUL.
14/06/99 Participation in the meeting of the ERCOFTAC Belgian Pilot Center, for organisation of the annual ERCOFTAC One-Day Seminar.

13/10/99 15/10/99 Visit to SABIGO, Moscow, with other team members from Transport Canada, Oracle Telecomputing and Carleton University, in the framework of the VFS development and validation.

10/11/99 Participation in the meeting of the Belgian LES research group, organised by Prof. Martine Baelmans at KUL.

21/11/99 23/11/99 Participation in the 52nd Annual Meeting of the Division of Fluid Dynamics, American Physical Society, New Orleans, Louisiana, and presentation of a communication: "Explicit filtering LES using the tensor-diffusivity model supplemented by a dynamic Smagorinsky term". Also co-author of three other communications.

24/11/99 Participation in the "Rendez-Vous de l'Innovation", organized by REDE Hainaut, on the subject of ultrasonic pulverization.

7. Research funding

1 Federal Office for Scientific, Technical and 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

Training and Mobility of Researchers

- *Project title* : Dynamics of Polymeric Liquids : The relation between fluid structure, Properties and Performance
- *Promotor* : R. Keunings
- *Partners* : Delft University of Technology, Eindhoven University of Technology, University of Stuttgart, University of Wales (Aberystwyth and Swansea), Cambridge University, Université Joseph Fourier Grenoble, Technical University Denmark, University of Naples.

Training and Mobility of Researchers

- *Project title* : Dynamics of Polymeric Liquids : The relation between fluid structure, Properties and Performance
- *Promotor* : R. Keunings
- *Partners* : Delft University of Technology, Eindhoven University of Technology, University of Stuttgart, University of Wales (Aberystwyth and Swansea), Cambridge University, Université Joseph Fourier Grenoble, Technical University Denmark, University of Naples.

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.

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.

Training and Mobility of Researchers

- *Project title* : The Algebraic Approach to Performance Evaluation of Discrete Event Systems (ALAPEDES).
- *Promotor* : V. Blondel
- *Partners* : Technische Universiteit Delft (The Netherlands), Ecole des Mines (Paris, France), INRIA (Paris, France), Katholieke Universiteit Leuven (Louvain, Belgium), Hewlett-Packard Limited (Bracknell, UK), Université Pierre et Marie Curie (Paris, France), Rijksuniversiteit Groningen (Groningen, The Netherlands).

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

- *Project title* : Optimal Management of Wastewater Systems (COST action 624)
- *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* : NTUA (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, Glasgows, 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 Norwich, U.K. INRA, France.

FAIR

- *Project title* : Advanced monitoring and control of the operation of wastewater treatment processes of the wood industry in order to improve the process efficiency
- *Promotor* : D. Dochain
- *Partners* : LBE-INRA (Narbonne, France), CNRS (Perpignan, France), Univ. de Santiago de Compostella (Espagne), Univ. de Porto (Portugal),Tafisa (Espagne), Cida Hidroquimica (Espagne).

SOCRATES

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

BATCHPRO

- *Project title* : Improving Human Potential and the Socio-Economic Knowledge Base Knowledge driven batch production.
- *Promotor* : D. Dochain

3 Regional Programmes

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 geometries.
- *Promotors :* D. Carati (ULB), G. Winckelmans and V. Legat (UCL).

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)

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 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* : Modelling of the mechanical and thermal behavior of thermometric probes. Phase II.
 - *Promotors* : G.Winckelmans and J.-M. Seynhaeve
 - *Collaborator* : H. Jeanmart

- **ARIA Technologie, France**
 - *Project title* : Study of vessel depressurization following a small breach.
 - *Promotors* : G.Winckelmans and J.-M. Seynhaeve

- **SCK-CEN, Belgium**
 - *Project title* : Myrrha project: design, numerical modeling, and experimental modeling for a windowless design of the spallation target for new ADS-type reactors. Phases I and II.
 - *Promotors* : G. Winckelmans, L. Bolle and J.-M. Seynhaeve.
 - *Collaborator* : H. Jeanmart

- **SEGAL Industry, Belgium**
 - *Project title* : Study of injector alimentation for galvanized products.
 - *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

- **SOVITEC**

- *Project title* : Modelling and control of glass grinding processes
- *Promotor* : G. Bastin, V. Wertz

- **USINOR-CARLAM**

- *Project title* : Modelling and control of cooling processes in hot rolling mills
- *Promotor* : G. Bastin

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.)

- **NATO International Scientific Exchange Programmes, Collaborative Research Grant**
 - *Promotor:* V. Blondel (UCL)
 - *Partners:* J. Tsitsiklis (MIT, Cambridge, USA), E. Asarin et V. Kozyakin (Academic of Science, Moscow)

8. Scientific awards and responsibilities

Scientific Awards

- **Denis Dochain** (UCL)
 - Best Referee Award for the Journal of Process Control
- **Michel Gevers**(UCL)
 - Fellow of the IEEE (Institute of Electrical and Electronics Engineers)
 - Distinguished member of the IEEE Control Systems Society
 - Distinguished lecturer of the IEEE Control Systems Society (1998-2000)

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 this Council, he contributed at the redaction of an important report entitled ”De la protection de l’Environnement au Développement Durable”.

- M. Installé is the manager/coordinator of various postgraduate programmes of the UCL in the field of environmental sciences.
- M. Installé was elected member of the "Commission de l'environnement de l'UCL".

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.

VAN DOOREN Paul

- Editor-in-chief, SIAM Journal on Matrix Analysis and Applications, SIAM Publ.
- Associate Editor, SIAM Journal on Control and Optimization, SIAM Publ.
- Associate Editor, Numerische Mathematik, Springer-Verlag, Berlin.
- Associate Editor, Linear Algebra and its Applications, Elsevier, North Holland.
- Associate Editor, Journal Comp. & Appl. Mathematics, Elsevier, North Holland.
- Associate Editor, Numerical Algorithms, Baltzer.
- Associate Editor, Applied Mathematics Letters, Pergamon, Oxford.
- Associate Editor, Electronic Transactions on Numerical Analysis
- Associate Editor, Applied and Computational Control, Signals and Systems, Birkhauser
- Associate Editor, Mathematics of Control, Signals and Systems, Springer
- Steering Committee International Symposium of Mathematical Theory of Networks and Systems
- Steering Committee Householder Symposium
- Member Mathematics Subcommittee of the Fonds National de la Recherche Scientifique and of the Fonds voor Wetenschappelijk Onderzoek

WERTZ Vincent

- Head of Automatic Control Laboratory
- Member of the Conference Editorial Board of IEEE-CSS

WINCKELMANS Grégoire

- UCL Representative for the European Community on Flow, Turbulence and Combustion (ERCOFTAC), including the ERCOFTAC Belgian Pilot Center (BPC).