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OCCASION

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FINAL REPORT

Training Course on

“Sustainable Industrial Development :

Process Simulation, Analysis, Optimization and Control”

*A training course on process simulation and decision-support systems within
the framework of the industrial sustainable development*

***Bangkok, Thailand
8-12 July 2002***

organized by
ICS-UNIDO

in collaboration with the
UNIDO Regional Office, Bangkok, Thailand

and the
***Technology Promotion Division of the
Department of Environmental Quality Promotion,
Bangkok, Thailand***

BACKGROUND

One of the premier goals of Subprogramme 2.1 of ICS-UNIDO, which specifically deals with Decision-Support Systems for Sustainable Industrial Development, is the distribution of knowledge on decision-support systems towards developing countries. In this area, the Subprogramme acts as a "knowledge collection centre" to gain expertise on general issues such as process simulation, environmental simulation, remote sensing and geographical information systems, and to acquire skills in using the relevant information tools which implement the general ideas. The Subprogramme also acts as a prime mover to facilitate a direct action in the field of monitoring systems, risk analysis and assessment, as well as the effective transfer of technology in response to environmental problems caused by industrial activities.

In the specific area of process simulation, analysis, optimization and control, the topic has been presented and illustrated by specialists in a series of meetings and ad-hoc workshops. As follow-up of these activities, ICS started organizing several training courses with the aim of presenting the state of the art in process simulation and optimization, as well as in control system and dynamic simulation, and of providing case studies, exercises and hands-on sessions. The experience gained during these activities together with the suggestions received from the participants drove us to continue organizing the courses directly in the developing countries, providing locally lectures and process simulation laboratory.

During the above mentioned activities, an issue which was highlighted as a major problem is the lack of adequately trained personnel in the technical communities and a lack of knowledge of the possibilities of process simulation and optimization in the decision making environment. In the developing countries, it is often the case that professional personnel, notwithstanding they are already thinly spread, are occasionally expected to perform functions beyond their technical remit. In recognizing the urgent need for developing human resource capabilities, ICS-UNIDO is attaching much importance to the training-of-trainers in the field of process simulation and optimization, with particular attention to the role of such topics within the framework of sustainable industrial development.

Well-trained personnel would be an invaluable asset to environmental and planning agencies, which deal with complex environmental issues and problems as well as the protection and conservation of the environment on a daily basis. Such interdisciplinary knowledge would also bring about a better appreciation and understanding of the magnitude of the potential risks involved.

The present activity is the natural consequence of this evangelization process and aims at organizing a similar Training Course in Bangkok.

JUSTIFICATION

In the Third Millennium "sustainability" is increasingly becoming a key social, political, scientific and engineering issue. Indeed, there are increasing signs that sustainability will become a major new paradigm influencing the society of tomorrow and the engineering it requires. With their knowledge of chemistry and physics, mass and energy flows, and process technology, chemical engineers are in a pre-eminent position to play a major role in implementing sustainable development. This role is wide. Traditionally it concerns the design and operation of chemical process plants. Nowadays it also concerns ethical and rational public policy involving science and technology.

The sustainable development, which can very simply be defined as a process in which one tries not to take more from nature than nature can replenish, can be obtained without sacrificing the many benefits that modern technology has brought. The only problem is that technology respects the imposed constraints. Engineers are asked to do this by designing new processes and/or by modifying existing processes aiming at using renewable resources and producing by products that can be returned to the earth.

Decision-support systems are a set of decision-making tools that are designed to help decision-makers to take appropriate steps in the development of new ideas and new concepts. A complete decision-support system is made up by different components, the most important being the experience and the knowledge.

Process Simulation and Optimization can play a dramatically important role in the decision-support system in the framework of sustainable development by allowing engineers to perform process screening and a priori analysis on the feasibility of a given industrial plan as well as performing simulation of performances of waste water treatment and air pollution control. Integration of three fundamental topics: (i) steady state process simulation, (ii) environmental simulation and (iii) process control can give, in the framework of the sustainable development theory, a solution for a decision-making system in developed and developing countries.

For these reasons, there exists the urgent need to transfer consciousness and familiarity with information tools and techniques implementing the three general topics mentioned above. In this respect, ICS-UNIDO organized a Training Course, covering various aspects of process simulation, analysis, optimization and control.

OBJECTIVES

- To set-up a training course considering process simulation within the framework of sustainable industrial development, to be used during the present course, and to be considered for the development of training courses to be made available to developing countries;
- To present the necessary background and basic principles necessary to understand and use the informatics tools implementing process simulations, process control and optimization techniques;
- To describe and teach "how to use" specific programs by means of demo and "hands-on" sessions;
- To explain how to tackle a simulation problem by showing the sequential steps to be considered in the development of a simulation and optimization strategy;
- Participants will gain perspective and insight into the potential applications of simulation and optimization techniques, as well as experience in the use of specific computer tools that are currently available.

STRUCTURE OF THE COURSE

The training course was directed to technologists, planners and decision-makers working in close contact with industry, particularly engineers, scientists and managers interested in the state-of-the-art applications of computer-based techniques for modeling chemical process. The pre-requisites included a working knowledge of chemical engineering and/or experience in the process industry and a familiarity with the use of computers to solve engineering problems.

The final selection was made under the responsibility of the Director of the ICS Area of Environment in accordance with the objectives of the training course and the profile of the candidates. Three participants from Cambodia, one from Indonesia, one from Kuwait, one from Lao PDR, two from Malaysia, two from Philippines, one from Vietnam and nine from Thailand attended the training course.

- The Training Course was held at the Technology Promotion Division of the Department of Environmental Quality Promotion, Bangkok, Thailand.
- The Training Course was organized in morning sessions in which theoretical and basic subjects were presented in form of formal lectures. Each afternoon (excluded the first day of the course) an electronic workshop session was held in which participants practiced on fundamental techniques for solving on-the-job problems. Some of the afternoon sessions were devoted to working in small groups on the solution of case study problems using the computing facilities. Local organizers provided a suitable room, as well as 10 networked personal computers, printer, projector and other equipment for the practical part of the Training Course.

- All the activities were organized under the responsibility of the Director of the Area of Earth, Environmental and Marine Sciences and Technologies, Mr. G. Longo and the training course was carried out according to the attached programme.

RESULTS

- Training material in the form of Power Point slides to be used as rough material for training modules and to be distributed "as is" to the participants;
- A set of examples of application of the topic discussed in the course to be distributed to the participants;
- A Web Site and a CD-ROM containing all the documents and material distributed at the training course.

CONCLUSIONS AND RECOMMENDATIONS

At the end of the training course, the most important messages addressed to the participants were the following:

- Information tools may be useful in the chemical process simulation environment;
- Sustainable industrial development can be obtained combining Process simulation, Environmental simulation and Process control;
- Process simulation is a simple tool to be used by trained people with engineering knowledge;
- Process simulation is a tool that does not interpret results: the presence of a trained engineer is essential;
- It is possible and desirable to apply process simulation in the entire life-cycle of the plant.

In order to have an opinion on the training course by the participants, an evaluation questionnaire was distributed. Relevant statistics were prepared and attached to this report.

IMMEDIATE FOLLOW-UP

- Setting up of a Web site at ICS containing all the training course material;
- Preparation of a CD ROM containing all didactic material to be sent to the local organizer;
- Setting up of a mailing list of the participants of the training course to facilitate contacts among them.

LIST OF ANNEXES

PROGRAMME

See attached Annex I.

LIST OF PARTICIPANTS

See attached Annex II.

CURRICULA OF LECTURERS

See attached Annex III.

LECTURE NOTES AND PRESENTATIONS

See attached Annex IV.

STATISTICS

See attached Annex V.



19.06.02
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PROGRAMME

***Training Course on
"Sustainable Industrial Development: Process
Simulation, Analysis, Optimization and Control"***

*A training course on process simulation, analysis, optimization and control
within the framework of the industrial sustainable development*

*Bangkok, Thailand
8-12 July 2002*

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UNIDO Field Representation, Bangkok, Thailand

and the

***Technology Promotion Division of the
Department of Environmental Quality Promotion,
Bangkok, Thailand***

Monday, 8 July 2002

Morning Session

- 08:30 - 09:00 Registration
09:00 - 10:00 Opening Session
- Capt. Paradee. Bhovichitra , Technology Promotion Division, DEQP
 - Mr. Gennaro Longo , ICS- UNIDO
 - Mr. Claudio Scaratti , UNIDO Field representative in Thailand
 - Mr. Riccardo Smimmo, First Secretary, Italy Embassy
 - Ms. Monthip Srirattana Tabucanon , Deputy Director – General, DEQP
- 10:00 - 10:20 Coffee break
10:20 - 10:40 Presentation of ICS activities, Mr. G. Longo, ICS-UNIDO
10:40 - 11:10 Presentation and scope of the Training course, Mr. M. Fermeglia, ICS-UNIDO
11:10 - 11:25 Short presentation of the participants
11:25 - 11:30 Information on local arrangements
11:30 - 13:00 Sustainable industrial development in chemical productions, Mr. A. Bertucco, University of Padua, Italy
13:00 - 14:30 Lunch break

Afternoon Session

- 14:30 - 16:00 Process Simulation fundamentals and techniques (part 1), Mr. M. Fermeglia
16:00 - 16:30 Coffee break
16:30 - 18:00 Process Simulation fundamentals and techniques (part 2), Mr. M. Fermeglia

Tuesday, 9 July 2002

Morning Session

- 09:00 - 10:30 Steady State Process Simulation: user interface and philosophy, Mr. M. Fermeglia
10:30 - 11:00 Presentation of the User interface of different commercial products, Mr. M. Barolo, University of Padua, Italy, Mr. A Bertucco, Mr. M. Fermeglia
11:00 - 11:30 Coffee break
11:30 - 13:00 Data banks, physical property calculation, thermodynamic, phase equilibria models and single stage operations, Mr. M. Fermeglia
13:00 - 14:30 Lunch break

Afternoon Session

- 14:30 - 16:00 Hands-on: Steady State Process simulation user interface, thermodynamics and single stage unit operations, Mr. M. Barolo, Mr. A. Bertucco, Mr. M. Fermeglia, Mr. G. Longo
16:00 - 16:15 Coffee break
16:15 - 17:30 Hands-on (continuation)

Wednesday, 10 July 2002

Morning Session

- 09:00 - 10:45 Industrial applications of process simulation: counter-current separation units (distillation, absorption, stripping) with examples and case studies, *Mr. A. Bertucco*
- 10:45 - 11:15 Coffee break
- 11:15 - 13:00 Complex separation units: conventional and supercritical fluid extraction with examples and case studies, *Mr. A. Bertucco*
- 13:00 - 14:30 Lunch break

Afternoon Session

- 14:30 - 16:00 Hands-on: industrial applications, *Mr. M. Barolo, Mr. A. Bertucco, Mr. M. Fermeglia, Mr. G. Longo*
- 16:00 - 16:15 Coffee break
- 16:15 - 17:30 Hands-on (continuation)

Thursday, 11 July 2002

Morning Session

- 09:00 - 10:45 Chemical Reaction simulation and modelling with examples, *Mr. M. Fermeglia*
- 10:45 - 11:15 Coffee break
- 11:15 - 13:00 Batch Distillation: theory, practice and examples, *Mr. M. Barolo*
- 13:00 - 14:30 Lunch break

Afternoon Session

- 14:30 - 16:00 Hands-on: industrial applications, *Mr. M. Barolo, Mr. A. Bertucco, Mr. M. Fermeglia*
- 16:00 - 16:15 Coffee break
- 16:15 - 17:30 Industrial case studies, *Mr. M. Barolo, Mr. A. Bertucco, Mr. M. Fermeglia, Mr. G. Longo*

Friday, 12 July 2002

Morning Session

- 09.00 – 10.30 Fundamentals of Process Dynamics and Control: Part I, *Mr. M. Barolo*
- 10.30 – 11.00 Coffee break
- 11.00 – 12.30 Fundamentals of Process Dynamics and Control: Part II, *Mr. M. Barolo*
- 12.30 – 13.00 Introduction to the hands-on session, *Mr. M. Barolo*
- 13.00 – 14.30 Lunch break

Afternoon Session

- 14.30 – 16.00 Hands-on: fundamentals of process dynamics and control, *Mr. M. Barolo, Mr. A. Bertucco, Mr. M. Fermeglia*
- 16.00 – 16.15 Coffee break
- 16.15 – 17.00 Case study on Dynamic simulation, *Mr. M. Barolo, Mr. M. Fermeglia*
- 17.00 – 17.45 Questions and Answers and Discussion
- 17.45 – 18.00 Closure, *Mr. G. Longo*



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AIDE-MÉMOIRE

***Training Course on
Sustainable Industrial Development:
Process Simulation, Analysis,
Optimization and Control***

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In the specific area of process simulation, analysis, optimization and control, the topic has been presented and illustrated by specialists in a series of meetings and ad-hoc workshops. As follow-up of these activities, ICS started organizing several training courses with the aim of presenting the state of the art in process simulation and optimization, as well as in control system and dynamic simulation, and of providing case studies, exercises and hands-on sessions. The experience gained during these activities together with the suggestions received from the participants drove us to continue organizing the courses directly in the developing countries, providing locally lectures and process simulation laboratory.

During the above mentioned activities, an issue which was highlighted as a major problem is the lack of adequately trained personnel in the technical communities and a lack of knowledge of the possibilities of process simulation and optimization in the decision making environment. In the developing countries, it is often the case that professional personnel, notwithstanding they are already thinly spread, are occasionally expected to perform functions beyond their technical remit. In recognizing the urgent need for developing human resource capabilities, ICS-UNIDO is attaching much importance to the training-of-trainers in the field of process simulation and optimization, with particular attention to the role of such topics within the framework of sustainable industrial development.

Well-trained personnel would be an invaluable asset to environmental and planning agencies, which deal with complex environmental issues and problems as well as the protection and conservation of the environment on a daily basis. Such interdisciplinary knowledge would also bring about a better appreciation and understanding of the magnitude of the potential risks involved.

The present activity is the natural consequence of this evangelization process and aims at organizing a similar Training Course in Bangkok.

JUSTIFICATION

In the Third Millennium "sustainability" is increasingly becoming a key social, political, scientific and engineering issue. Indeed, there are increasing signs that sustainability will become a major new paradigm influencing the society of tomorrow and the engineering it requires. With their knowledge of chemistry and physics, mass and energy flows, and process technology, chemical engineers are in a pre-eminent position to play a major role in implementing sustainable development. This role is wide. Traditionally it concerns the design and operation of chemical process plants. Nowadays it also concerns ethical and rational public policy involving science and technology.

The sustainable development, which can very simply be defined as a process in which one tries not to take more from nature than nature can replenish, can be obtained without sacrificing the many benefits that modern technology has brought. The only problem is that technology respects the imposed constraints. Engineers are asked to do this by designing new processes and/or by modifying existing processes aiming at using renewable resources and producing by products that can be returned to the earth.

Decision support systems are a set of decision-making tools that are designed to help decision makers to take appropriate steps in the development of new ideas and new concepts. A complete decision support system is made up by different components, the most important being the experience and the knowledge.

Process Simulation and Optimization can play a dramatically important role in the decision support system in the framework of sustainable development by allowing engineers to perform process screening and a priori analysis on the feasibility of a given industrial plan as well as performing simulation of performances of waste water treatment and air pollution control. Integration of three fundamental topics (i) steady state process simulation, (ii) environmental simulation and (iii) process control can give, in the framework of the sustainable development theory, a solution for a decision making system in developed and developing countries.

For these reasons, there exists the urgent need to transfer consciousness and familiarity with informatic tools and techniques implementing the three general topics mentioned above. In this respect, ICS-UNIDO shall be organizing a Training Course, covering various aspects of process simulation, analysis, optimization and control.

OBJECTIVES

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- Participants will gain perspective and insight into the potential applications of simulation and optimization techniques, as well as experience in the use of specific computer tools that are currently available.

OUTPUTS

- Training material in the form of Power Point Slides to be used as rough material for training modules and to be distributed 'as is' to the participants.
- A set of examples of application of the topic discussed in the course to be distributed to the participants.

STRUCTURE OF THE COURSE

The Course is organized in morning sessions in which theoretical and basic subjects will be presented in form of formal lectures. Each afternoon (excluded the first day of the course) an electronic workshop session will be held in which participants will practice on fundamental techniques for solving on-the-job problems. Some

of the afternoon session will be devoted to working in small groups on the solution of case study problems using the computing facilities.

PARTICIPATION

The Course is directed to technologists, planners and decision-makers who are working in close contact with industry, particularly engineers, scientists and managers interested in state-of-the-art applications of computer-based techniques for modeling chemical process, coming from Far East countries.

The prerequisites include a working knowledge of **chemical engineering** and/or experience in the process industry and a familiarity with the use of the computer to solve engineering problems.

TENTATIVE PROGRAMME

During the course the following topics will be covered:

Sustainable Industrial Development and Industrial Ecology

Process simulation: Fundamentals and techniques

Environmental Applications

Thermodynamic modeling: data banks, physical property determination, phase equilibria models.

Steady state process simulation: user environment

Single stage unit operations

Steady state process simulation: processes with reaction

Steady state process simulation: complex unit operations: distillation, crystallization

Steady state process simulation: application to simple processes

Optimization techniques

Fundamentals of Process Dynamics and Control

Case studies

DOCUMENTATION

The documents available for the course shall be:

- Aide-mémoire of the Consultation Workshop.
- Programme and list of participants.
- Power Point slides (hardcopy) of all the lectures and examples.
- Any other relevant documentation.

LANGUAGE

The Course will be conducted in English; no translation facilities will be available.

TIME AND VENUE

The Course will be held at the Department of Environmental Quality Promotion, Ministry of Science, Technology and Environment, 49 Rama VI Soi 30, Rama VI Road, Bangkok, 10400, Thailand, Tel.: +662-2450746/2460064 ext. 620/622, Fax: +662-2450746/2473246, from 8 to 12 July 2002.

FINANCIAL ARRANGEMENTS FOR ICS-UNIDO FUNDED PARTICIPANTS:

For those who will be invited by ICS-UNIDO to participate to the Training Course, round-trip air-economy transportation from the airport of departure will be arranged and prepaid tickets issued where necessary, as well as expenses for board and lodging during the activity. Reservation will be made for all participants at the same hotel.

The participants will be required to bear the following costs:

All expenses in their home country incidental to travel abroad, including expenditures for passport, visa, and any other miscellaneous items. ICS-UNIDO will not assume responsibility for any of the following costs, which may be incurred by the participant while attending the meeting:

- (1) compensation for salary or related allowances during the period of the training course;
- (2) any costs incurred with respect to insurance, medical bills and hospitalization fees;
- (3) compensation in the event of death, disability or illness;
- (4) loss or damage to personal property of participants while attending the training course.

VISA ARRANGEMENTS

Participants are requested to arrange for their visa, if one is necessary, as early as possible in their home country. In case of difficulties, please advise the ICS contact person (details below).

CONTACT PERSONS

For additional information, please contact:

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**Training Course on "Sustainable Industrial Development: Process
Simulation, Analysis, Optimization and Control
Bangkok, Thailand
8 - 12 July, 2002**

List of participants

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Curriculum Vitae

Mr. Gennaro Longo

Mr. Maurizio Fermeglia

Mr. Alberto Bertucco

Mr. Massimiliano Barolo

Curriculum Vitae

Gennaro Longo

He got his degree in Chemical Engineering at the University of L'Aquila on 1974. After his degree he attended several courses, seminars, etc. in process simulation and technology development, as well as in programming and informatics techniques.

During 1975/76 he has started teaching Chemistry and Inorganic Chemistry at the Technical High School of Rieti.

From 1976 to 1997 he has worked at CTIP (Compagnia Tecnica Internazionale Progetti), Rome, Italy as: Process Engineer, Project Manager, Head of Process Systems Engineer, Manager of Systems Engineering, Manager of the Computer Department, Proposal Manager, Technology and Licensing Manager.

During 1997 he worked for the CASALE Group, Lugano, Switzerland as Proposal Manager, dealing with the preparation of commercial offers for the four companies of CASALE: Ammonia Casale, Urea Casale, Methanol Casale and Chemicals Casale.

At the beginning of 1998 he worked for the first months at the Municipality of Fiumicino, Rome, Italy as Manager of the Environment Sector.

Since May 1998 he works at the International Centre for Science and High Technology (ICS-UNIDO), Trieste, Italy, as Director of the Area of Earth, Environmental and Marine Sciences and Technologies.

He is responsible for all the activities carried out within this Area. In particular he is personally involved as expert on process simulation in all the activities implemented in this field.

He cooperates also with the Universities of Padua and Trieste at the Faculty of Chemical Engineering.

He has a wide experience in Process Simulation and Optimization of Chemical Plants by using different software tools like PROCESS, PRO/II, HEXTRAN, PIPEPHASE, VLE/REGRESS and ASPENPLUS.

He got the award as "Top European Process User" given by SIMSCI Inc. for the results obtained in the optimal use of the simulation process procedures.

MAURIZIO FERMEGLIA

He graduated in Chemical Engineering at the Engineering Faculty of the University of Trieste in 1980. He got his habilitation for chemical engineer in 1985. In 1981 and 82 he worked as visiting scientist at the Denmark Technical University (DTH). His current position is full professor of Chemical Engineering at the University of Trieste, where he holds the course in 'Computer Calculations in Chemical Engineering'. He is member of the Research Doctorate Council of the University of Padua and Trieste.

He has been involved in teaching for the following courses: Physics, Physical Chemistry, Computer calculation, Unit operations, Transport and thermodynamic properties measurements, Transfer processes and units, and he holds also the Data Base course at the University of Trieste.

He has been teaching courses and seminars for industries and academia on the following topics: phase equilibrium and thermodynamics, equilibrium properties calculation, process simulation, applied thermodynamics, molecular simulation. He held seminars on Programming, Operating Systems, Data Base, Networking, Internetworking, multimedia.

The main research activities are focused on transport and thermodynamic properties, their experimental determination, correlation and prediction, chemical process analysis and synthesis and molecular modeling. In computer science his main research activity is in the Data Base and Internet – Intranet. He is scientific consultant of ICS - UNIDO within the Subprogram 'Process Simulation' from 1999.

He is author of more than 160 publications in national and international journals and conference proceedings.

Four representative recent publications

- Prici S., Fermeglia M., Carbohydrate Polymers 45: 23-33 (2001) Molecular simulations of host-guest inclusion compounds: an approach to the lactodendrimers case.

- Favari F., Bertucco A., Elvassore N., Fermeglia M., Chemical Eng. Science 55: 2379-2392 (2000) Multiphase multicomponent equilibria for mixtures containing polymers by the perturbation theory.

- Belloni F., Fermeglia M., Prici S., Molecular Simulation 25: 1-19 (1999) From molecular to process simulation: novel approaches to the prediction of phase equilibria and PVT behaviour based on molecular/quantum mechanics and molecular dynamics simulations.

- Fermeglia M., Prici S., AIChE Journal 45: 2619-2627 (1999), Equation of state parameters for pure polymers by molecular dynamics simulations.

ALBERTO BERTUCCO

Alberto Bertucco was born in Verona, Italy, 1955.

In 1979 he graduated in Chemical Engineering at the Università di Padova, Italy. In 1983 he was appointed Assistant Professor of Chemical Engineering at the Università di Padova, in 1992 he became Associate Professor, and finally he has been Full Professor since November 1999. He is presently the chairman of DIPIC, the Department of Chemical Engineering of the Università di Padova.

His research interests were developed in many fields related to separation processes: applied fluid phase equilibria, control of distillation units, and especially supercritical fluid extraction. From 1990 on, he was particularly active in two fields: non-extractive applications of supercritical CO₂ and validation of commercial process simulators. He is the chairman of the Working Party High Pressure Technology of the European Federation of Chemical Engineering. In 1999 he organised the fifth International Conference on Supercritical Fluids and their Applications (Garda, Italy), and next year he will organise the fourth International Symposium on High pressure chemical and process technology (Venice, Italy, 22-25 Sept. 2002).

His teaching activities include courses on Unit operations, Biochemical Separations and applied physical chemistry, as well as lectures and workshops for PhD students on calculation of phase equilibria. He has joined ICS activities in the field of Process simulation as a decision support system since 1998.

He is the author or coauthor of about 100 scientific publications, 60 of which in refereed international journals of chemical and biochemical engineering.

Some representative publications

-BERTUCCO, V BENSO, "Simulatori di Processo a Confronto", RichMac Magazine, 41-46, marzo/aprile 1995.

-G.S. SOAVE, A. BERTUCCO, M. SPONCHIADO, "Avoiding the Use of Critical Constants in Cubic equations of State", AIChE J., 41, 1964-1971, 1995.

-A. Bertucco, G. STORTI, R. TOGNACCI, "Measurements of Monomer Partitioning in Emulsion Copolymerization Systems", JI. Appl. Polym. Sci., 62, 2341, 1996.

-M. BAROLO, A. BERTUCCO, N. ELVASSORE, "Thermodynamic Consistency of Vapor-Liquid Equilibrium Data at High Pressure", AIChE J., 43, 547-554, 1997.

-A. Bertucco, P. PALLADO, L. Benedetti, "Production of Micronic Particles of Biocompatible Polymer using Supercritical Carbon Dioxide", Biotech. Bioeng., 53, 232-23, 1997.

-KIKIC, M. LORA, A. Bertucco, "A Thermodynamic Analysis of Three-Phase Equilibria in Binary and Ternary Systems for Application in RESS, SAS and PGSS", Ind. Eng. Chem. Res., 36, 550-5515, 1997.

-KIKIC, M. LORA, A. Bertucco, "Fractional Crystallization by a Supercritical Antisolvent Technique: Theory and Experimental Test", AIChE J., 44, 2149-2158, 1998.

-FORNASIERO F., LUE L., BERTUCCO A., "Improving Cubic Equations of State near the Critical Point by the Phase-Space Cell Approximation", AIChE J., 45, 906-915 1999.

-A. BERTUCCO, "Precipitation and crystallization techniques", in: Chemical synthesis in supercritical fluids, P.G. Jessop e W. Leitner Eds., 108-126, ISBN/ISSN: 3-527-29605-0, 1999.

-F. BEZZO, M. BAROLO, A. BERTUCCO, A. FORLIN, "Steady-State Analysis of an Industrial Reactive Distillation Column", Separ. Sci. Technol., 16, 251-260, 1999.

-F. FAVARI, A. BERTUCCO, N. ELVASSORE, M. FERMEGLIA, "Multiphase Multicomponent Mixtures Containing polymers by Perturbation Theory", Chem. Eng. Sci., 55, 2379-2392, 2000.

-N. ELVASSORE, A. BERTUCCO, P. CALICETI, "Production of protein loaded polymeric microcapsules by supercritical CO₂ in mixed solvent", Ind. Eng. Chem. Res. 40, 731, 2001.

DR. Massimiliano BAROLO

Present appointment

Ricercatore universitario (Assistant Professor)

Work address

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Università di Padova
via Marzolo, 9
I-35131 Padova PD
ITALY
phone +39 049.827.5473
fax +39 049.827.5461
e-mail max.barolo@unipd.it
web: <http://mercurio.cheg.unipd.it/impianti/profs/max/max.htm>

Education

November 1991 – February 1994: *Dottorato di Ricerca* (Ph.D.) in Chemical Engineering, Università di Padova. Thesis title: "Model-Based Startup and Operation Control of a Distillation Column" (in Italian)
March 20th, 1990: Graduated with honors from the Università di Padova. *Laurea* in Chemical Engineering (110/110 *cum laude*)

Awards/Recognitions

1989: Award for best University career from FEDERCHIMICA
1988: Scholarship from MONTEDISON (Italian largest chemical/petrochemical company)

Appointments

Oct.1994 – present: Assistant Professor, Università di Padova
Feb.1994 – May 1994: Research assistant, Istituto per la Tecnica del Freddo, Italian National Research Council (CNR, Padova)
1991 – 1994: Ph.D. student, Istituto di Impianti Chimici, Università di Padova
1990 – 1991: Process Engineer at MONTEDISON (Porto Marghera, Italy)

Teaching responsibilities

Lectures and seminars in the following classes: Unit operations, Process dynamics and control, Basic chemical engineering calculations

Research interests and achievements

- Dynamics, simulation, optimization and control of conventional and unconventional batch distillation columns
- Dynamics and control of continuous distillation columns
- Development of "virtual" sensors for process monitoring and control

The results of his research activities are reported in about 40 papers that he authored or co-authored, and that have been published in the major international journals or have been presented in national and international conferences. He also serves as a reviewer for several international journals, conferences, and publishers.

Three representative recent publications

Barolo, M. (2000). Batch Distillation. In: *Encyclopedia of Separation Science* (I. D. Wilson et al., Eds.), Academic Press Ltd, London (U.K.), p.995-1004.
Barolo, M. and C. A. Papini (2000). Improving Dual Composition Control in Continuous Distillation by a Novel Column Design. *AIChE J.*, **46**, 146-159.
Bezzo, F., A. Bertucco, A. Forlin and M. Barolo (1999). Steady-State Analysis of an Industrial Reactive Distillation Column, *Separ. Purif. Technol.*, **16**, 251-260.

LECTURE DOCUMENT

I. Mr. Massimiliano Barolo

- 1 Batch Distillation
- 2 Fundamentals of process dynamics and control : Part I
- 3 Fundamentals of process dynamics and control : Part I

II. Mr. Maurizio Fermeglia

- 1 Process Simulation Fundamentals and Techniques
- 2 Process simulation software : User Interface and Interoperability
- 3 Data Banks Physical Property calculations and Thermodynamics
- 4 Chemical Reaction Simulation and Modelling
- 5 Case studies
- 6 Environmental applications of process simulation
- 7 Training Module : Process Simulation and Environmental Applications

III. Mr. Alberto Bertucco

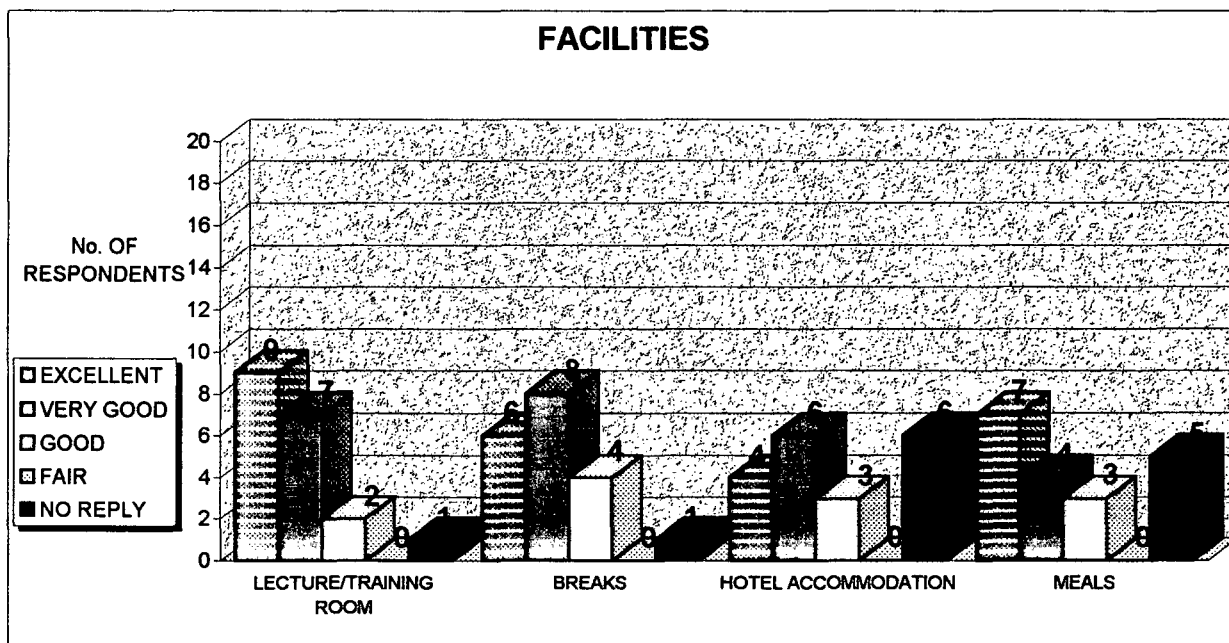
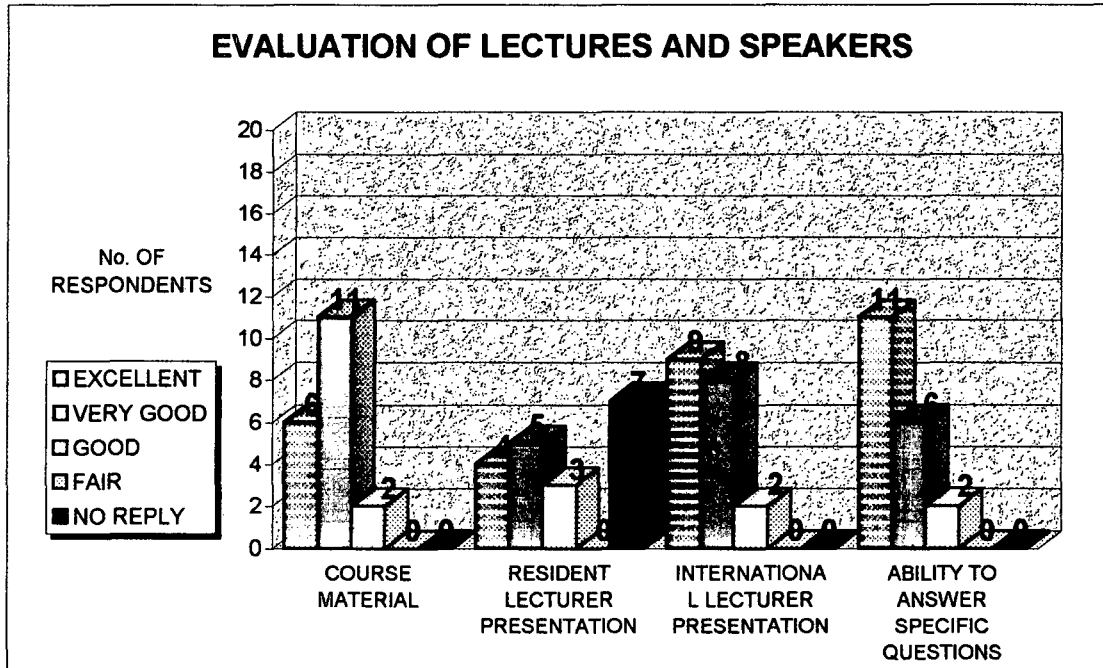
- 1 Sustainable Industrial Development in Chemical Productions
- 2 Industrial Applications of Process Simulation :
Counter - current Separation Units
- 3 Complex Separation Units : Conventional and Supercritical
Extraction
- 4 Supercritical Fluid Extraction
- 5 Industrial Case Studies
- 6 Case Studies : Solvent extraction with Caprolactam
- 7 Case Studies : Extractive Distillation of Butadiene

IV. Mr. Gennaro Longo

- 1 ICS - UNIDO

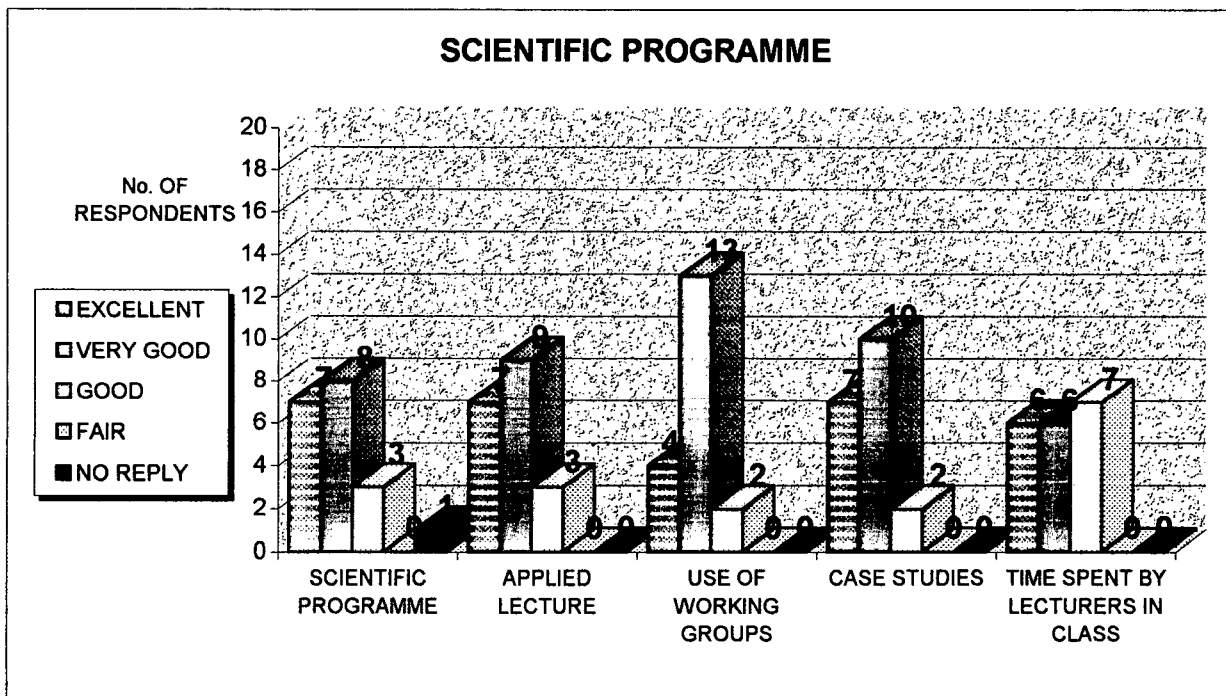
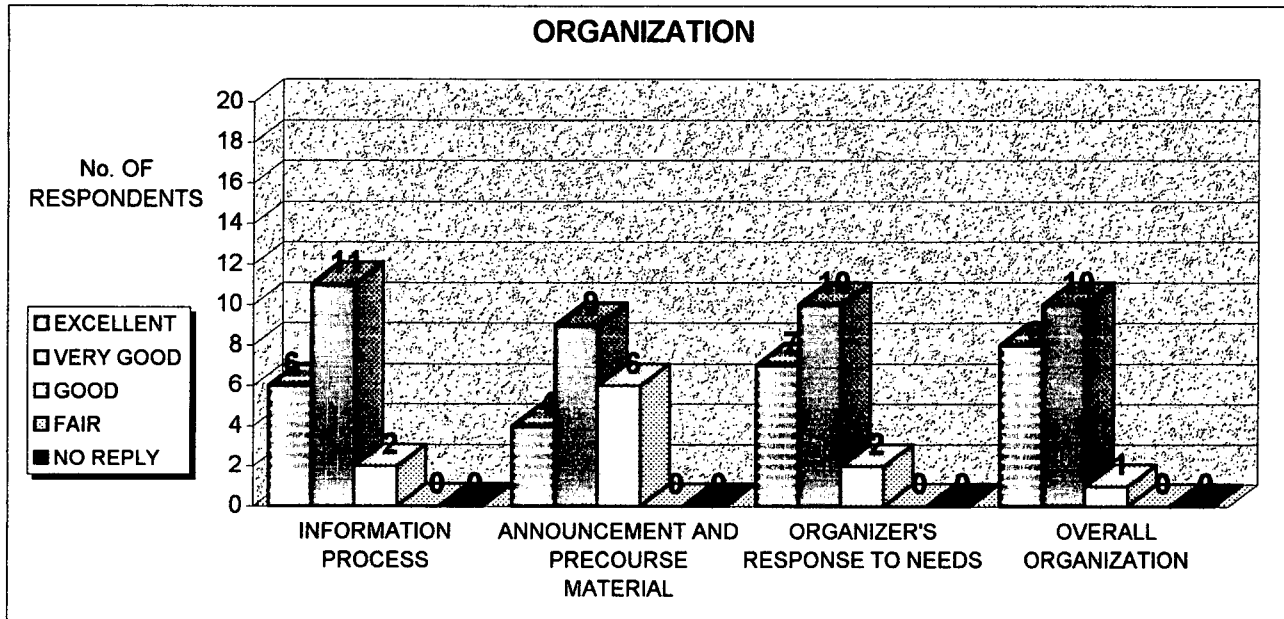
*Training Course on
 "Sustainable Industrial Development: Process Simulation,
 Analysis, Optimization and Control"
 Bangkok, Thailand
 8-12 July 2002*

EVALUATION



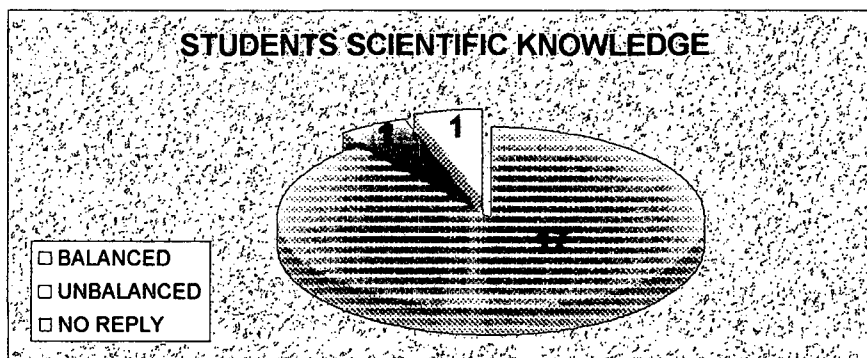
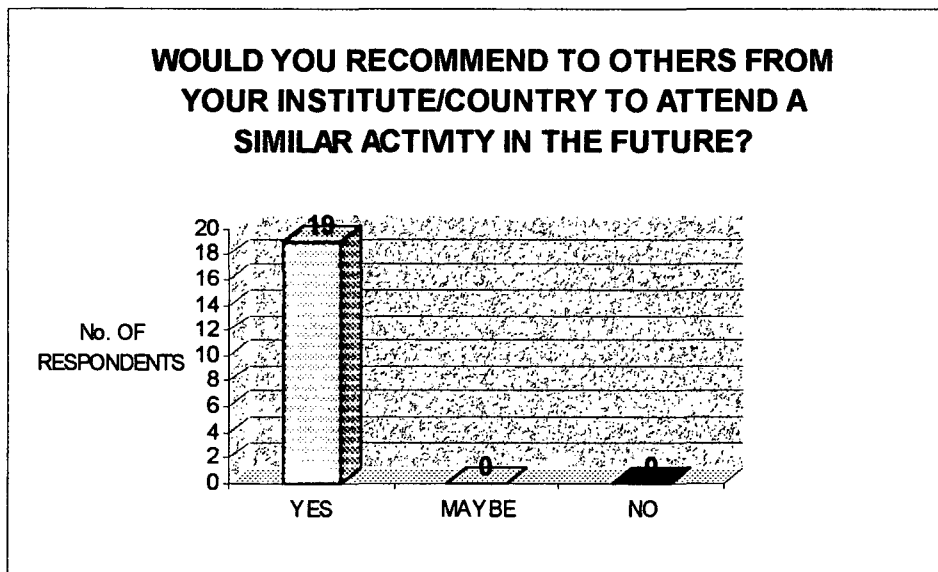
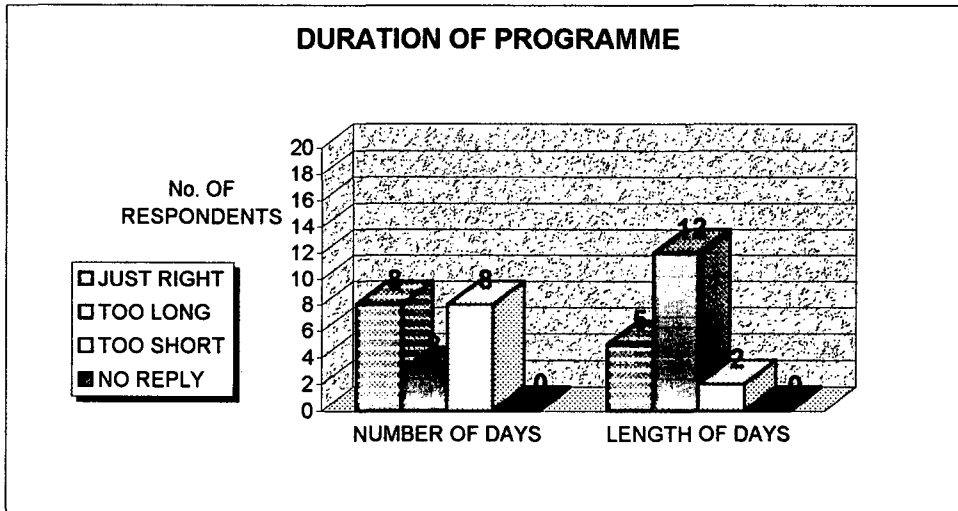
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 8-12 July 2002*

EVALUATION



*Training Course on
 "Sustainable Industrial Development: Process Simulation,
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 Bangkok, Thailand
 8-12 July 2002*

EVALUATION



ICS Workshop/Training Course: EVALUATION QUESTIONNAIRE

Training Course on: "Sustainable industrial development: process simulation, analysis, optimization and control", Bangkok, Thailand, 8-12 July 2002.

A. Organization:

1. How did you obtain information about this workshop/course?

	Excellent	Very Good	Good	Fair
2. The information process was	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The announcement and pre-course material was • Describe the content of the workshop/course:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. I found the scientific programme	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.1. Applied Lecture/Workshop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.2. Use of small working groups	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.3. Case Studies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.4. The time spent by lecturers in class and after class on specific questions/examples	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.5. Students scientific knowledge was	Balanced <input type="checkbox"/>	Unbalanced <input type="checkbox"/>		

B. Duration of programme:

	Just right	Too long	Too short
1. Number of days	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Length of working days	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C. Training facilities & Hotel:

	Excellent	Very Good	Good	Fair
1. Lecture/Training Rooms	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Breaks/refreshments	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Hotel accommodation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Meals at the hotel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If "Fair" please explain why: _____

D. Organizer's response to participants needs

E. Overall programme organization

F. Would you recommend to others from your institution/country to attend a similar activity in the future?

Yes Maybe No

1. Which part of the Activity did you find most useful?

2. Which part of the activity do you think should be expanded?

3. Which part of the activity do you think should be dropped?

4. Any other suggestions for future improvements to the programme?

5. Do you think that the topics/tools you studied during the course could be used by industries in you country? If so, how? If not, why not?

6. Can you suggest any programme and future activities, which ICS could pursue in order to help with the technological and scientific advancement of your country?

7. Do you think you have benefited from participation in this course/workshop? If so, how? and your Institution?

8. How do you intend to disseminate the information you have acquired during the activity once back in your own country?

G. Evaluation of Lectures and Speakers

	Excellent	Very Good	Good	Fair
1. Course material	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Resident Lecture presentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. International Lecture presentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Ability of lecturers to answer specific questions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Any comments:

Thank you for your collaboration.

04.06.02
GLO/esr

Supplementary questionnaire

- Which topic covered during the Training Course have you found closer to your technical background?

-Would you suggest to eliminate this topic from the lectures? NO YES

- Which topic have you found more far away from your technical background?

-Was the time reserved to this topic enough to get a sufficient understanding? NO YES

- Which of the case studies have you found most useful to appreciate the potential of process simulation?

- Which of the case studies was, on the other hand, harder to understand?

-What would you suggest for this case study?

To suppress it To improve it (please, provide your suggestion) _____

- Did this Training Course make you change your mind about process simulation?

NO YES (in a negative way in a positive way)

At the end of this Training Course, I have achieved a good familiarity with:
(please, check out what is most appropriate)

1. the general concept of process simulation

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

2. the general procedure for conducting a process simulation (base case, design specification, sensitivity analysis,...)

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

3. the user interface of a process simulator

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

4. the selection of thermodynamic models

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

5. counter-current separation units

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

6. conventional and non-conventional extraction processes

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

7. the optimization of industrial processes

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

8. batch distillation

Not applicable Completely disagree Disagree Partly agree Agree Completely agree

9. process dynamics and control

Not applicable Completely disagree Disagree Partly agree Agree Completely agree