ANNUAL·REPORT·91

Institute
FOR
Systems
Engineering
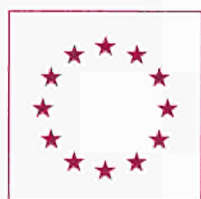## AND
Informatics

**JOINT
RESEARCH
CENTRE**

COMMISSION OF THE EUROPEAN COMMUNITIES

Institute
FOR
Systems
Engineering
AND
Informatics

JOINT
RESEARCH
CENTRE

Cataloguing data can be found at the end of this publication.

CONTENTS

1 EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

INTRODUCTION TO THE INSTITUTE

The Institute for Systems Engineering and Informatics is one of 8 Institutes which constitute the Joint Research Centre of the European Community, situated in 4 different sites in Europe (Ispra in Italy, Karlsruhe in Germany, Geel in Belgium and Petten in Holland).

The Joint Research Centre is a part of the General Directorate for Science, Research and Development (DG XII) as seen in the organigramme below.

PRESIDENT OF THE COMMISSION
17 COMMISSIONERS

Vice President P.M. Pandolfi
With special responsibility for
Science, Research and Development

| **DG XII**
Director General
P. Fasella | **DG XIII**
Director General
M. Carpentier |

Joint Research Centre
Director General
J.P. Contzen

| **Ispra Site**
Institute for Systems Engineering and Informatics
Director
R.W. Witty | **Ispra Site**
Institute for Prospective Technological Studies
Director
P. Bonnaure | **Ispra Site**
Environment Institute
Director
F. Geiss | **Ispra Site**
Institute for Remote Sensing Applications
Director
R. Klersy | **Ispra Site**
Safety Technology Institute
Director
H. Holtbecker |

| **Karlsruhe Site**
Institute for Transuraniens
Director
J. Van Geel | **Petten Site**
Institute for Advanced Materials
Director
E.D. Hondros | **Geel Site**
Central Bureau for Nuclear Measurements
Director
W. Müller |

Fig. 1.1: The Joint Research Centre in the organisation of the commission of the European Communities.

```
                    ┌─────────────────┐
                    │  Director of the │
                    │    Institute     │
                    │   R.W. Witty     │
                    └─────────────────┘
```

| Systems Engineering and Reliability | Non Nuclear Energy | Control of Fissile Materials | Informatics Services | Advanced Computing, Knowledge Based Application and Electronics | Management Support |
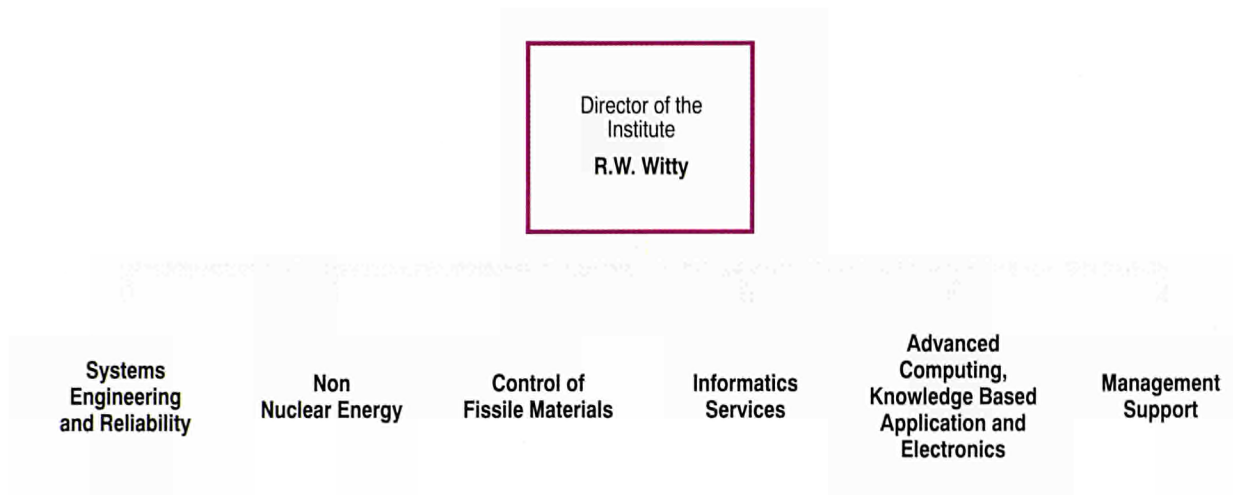
Fig. 1.2: Institute for Systems Engineering and Informatics Organigramme.

Permanent S/T	221
Permanent Adm.	27
Auxiliarly Agents	3
Detached Experts	5
Grant Holders	31
Visiting Scientists	1
Stagiaires	17

0,3% 5,5% 10,5% 1,6% 1% 10,2% 72,5%
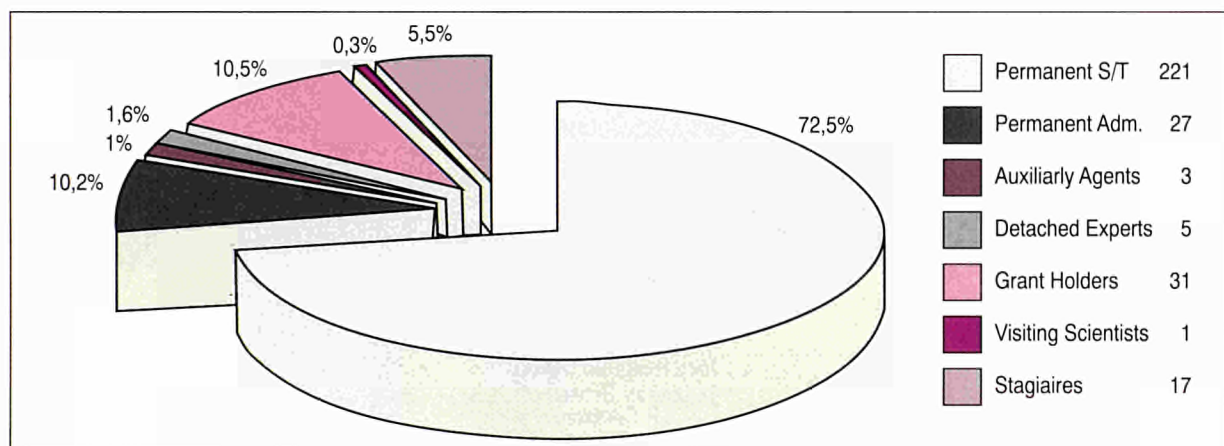
Fig. 1.3: Human Resources - 31.12.1991 (total staff = 305).

In Mio ECU

Framew. Programme	1.85
Administration	0.29
Informatics Centre	5.12
Support to the Commission	3.30
3rd Party Work	0.33
Special Projects	8.00
Exploratory Research	0.40

2.1% 9.6% 1.5% 41.5% 26.5% 1.7% 17.1%

Fig. 1.4: Financial Resources 1991 - Research Credits.

The Institute for Systems Engineering and Informatics is divided into six units. One unit is dedicated to management support, one to informatics services and 4 research units: systems engineering & reliability, non-nuclear energy, control of fissile materials and advanced computing, knowledge based application & electronics *(Fig. 1.2)*.

The **Institute** currently incorporates 248 permanent staff with an additional 57 doctorate, postdoctorate students, visiting scientists and detached national experts *(Fig. 1.3)*.

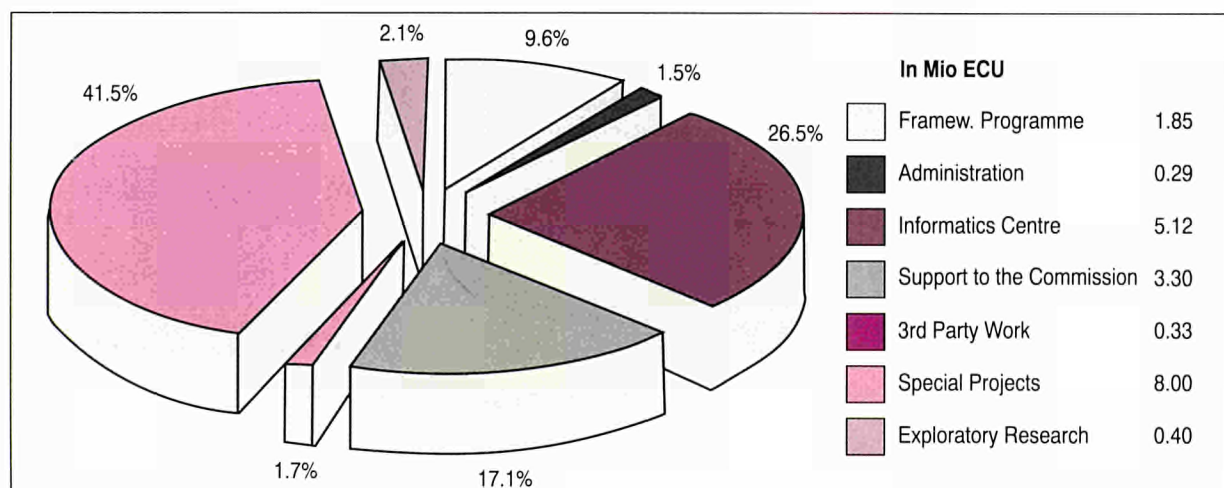In 1991 the financial resources for research of the Institute were 18,89 Mio ECU *(Fig. 1.4)*.

STRUCTURE OF THE REPORT

The report is structured according to the different types of activities of the Institute. Chapters 2 to 5 cover the main activities as Specific Programmes, Exploratory Research, Support to the Commission and Contract Research.

Chapter 6 gives a list of Associated Laboratories as a function of projects whereas chapters 7 to 9 are related to Participation in EUREKA Projects, Special Commission Projects and the Large Installations of the Institute.

The Annexes include the List of Publications, the List of Figures in the report and a Glossary of Acronyms and Abbreviations.

SUMMARY OF THE REPORT

During the year 1991, the work undertaken by the Institute can be classified under the following main headings:

- *Specific programmes: part of the 1988-1991 Framework Programme of CEC research.*
- *Exploratory research: small, long term projects.*
- *Support to the Community policies and the services of the Commission.*
- *Work for Third Parties: contract research*
- *Associated laboratories.*
- *Participation in Eureka projects.*
- *Special projects.*
- *Large installations and services.*

Brief details of the work carried out under each of the above topics is summarised below.

Specific Programmes

Work under this heading was in the areas of:

- Reactor safety,
- Safeguards & Fissile Material Management,
- Industrial Hazards,
- Non-Nuclear Energy Reference Methods,
- Structural Reliability and
- Fusion.

In the field of **Reactor Safety** the Institute maintained several data bases which are freely available to other research organisations. Data analysis on topics of interest to plant safety was actively pursued, as was further development of the System Response Analyser.

Under **Safeguards** a new nuclear fuel cycle database has been set up in addition to another which deals with safeguards R&D activities. Development of evaluation tools for statistical analysis of accountancy data of nuclear materials, and for evaluating the results of volume and mass determination in liquid tanks, continued, along with surveillance techniques for remote verification in storage areas.

In the **Industrial Hazards** field, further progress has been made in the FIRES experiment; Human Factors in Risk Prevention; Decision Support Systems for Envi-

ronmental Management; Risk Communication; the STARS project.

Concerning **Non Nuclear Energy**, the work was mainly in the field of photovoltaic cells, with emphasis on the development of testing methods.

Under **Structural Reliability**, the main effort was devoted to the reliability modelling of structures and to the development of data treatment for the new Reaction Wall experiment.

In the **Fusion** field the three main areas of activity were in support to NET, to JET and long term studies on Low Activation Materials for possible future use in fusion reactors.

Exploratory Research

Several projects were more involving the use of Neural Networks in applications for Time Series Analysis, for Remote Sensing of Images and for Safeguards use. In the first case the main goals are to realise a network for economic time forecasting and to develop both methods and tools best suited for various kinds of time-series analysis. Another activity is exploring the role of the use of neural network approaches for the analysis of remote sensing data. The safeguards use is looking at the feasibility of seal matching problems encountered in this area. Another project involves the use of lasers, 1) to use laser methods for the identification and quantification of the deterioration mechanisms affecting historical works of art and ancient buildings, and 2) a study of ways and means of reducing quantum noise of laser light to improve the resolution of measurements made by laser light beams.

Another area of research is in the field of the exploitation of Biological Adaptive Systems for Process control by the enhancement of fuzzy controllers using Genetic Algorithms. The aim is to carry out a "benchmark" study of three techniques inspired by studies of biological systems, namely Neural Networks, Genetic Algorithms and the Immune network, for the control of dynamic processes.

The last research activity is concerned with the reinforcement connectionist approach for Robot path finding.

Support to the Community Policies

These activities are divided into nine areas:

- Support to International Cooperation, where work is done in support of both DG I and IAEA in the areas of nuclear material accountancy, surveillance techniques, sealing and identification techniques and volume/mass determination.

- Support to Industrial Policy is concerned with the World Shipbuilding data bank, where the aim is the production of statistical tables on worldwide ship building.

- Support to Transport Policy where a comparison is made of existing data banks and reporting systems, dealing with aircraft incidents. A feasibility study is underway on the setting up of a European Coordination Centre for an Aircraft Incident Data Base.

- Support to Development Policy in the solar energy area.

- Support to Environmental Policy, in the areas of major accident hazards, biotechnology hazards and civil protection.

- Support to Telecommunications, Information and Industrial Innovation Policy. Work here has included the Advanced Networking support, the use of Distributed Artificial Intelligence for building problem solving, parallel computing applications within the ESPRIT context, secretariat assistance to COST activities and work on the VALUE programme for 3D image processing and solar technology transfer.

- Support to energy policy, both nuclear and non-nuclear. The nuclear tasks were to give technical support to Euratom safeguards. The non- nuclear work was in connection with the DG XVII THERMIE award scheme for energy saving in buildings and transport, and with solar energy (thermal and photovoltaic).

- Support to the Statistical office in Luxembourg on the statistical application of Artificial Neural Networks in problem solving.

- Support to the Secretariat General of the Commission in anti fraud coordination. This involved a feasibility study for a computer documentation system containing descriptions of national anti-fraud systems in the EEC, and in the setting up of a data base for the management of petitions presented to the European Parliament.

Work for Third Parties

This activity was introduced into the JRC in 1988, and is a current growth activity. The work was in three main areas:

- Non-Nuclear Energy: exploitation of the ESTI expertise and facilities in the photovoltaic area; and the development of operative tools for energy saving in a set of buildings in the region of Lombardy in Italy.

- Environmental and Industrial Risk: included under this heading has been the application of COSIMO to test real life operator behaviour at AEA Winfrith; assisting the National Nuclear Safety Administration in China with the setting up of special versions of certain ISEI data bases (viz AORS and CEDB); work on the MAPO project, which is concerned with the re-sanification of the river Po; development of the RITO project which aims at developping a Decision Support System for Industrial Waste Management; the conclusion of the BRITE project which is an expert system for maintenance and inspection optimisation of nuclear pressure vessels and offshore structures.

- Training: effort was devoted to the holding of several civil protection courses in Europe, and the presentation of a Reliability Data Bank course to a group in Rio de Janeiro.

Associated Laboratories

The Institute has established close and fruitful links with several European organisations in diverse projects. They are: STARS (as software tool for advanced reliability and safety analysis), FORMENTOR (Eureka#19), TOMHID (an overall knowledge-based methodology for hazard identification), HEAT (Human Error Analytical Taxonomy), and SRG (System Response Generator). It is also an active member of the EUROSAFE Club (this is a group whose aim is to create a European Interest Club in the field of risk management) and of the European Safety and Reliability Data Association (ESReDA).

It has also maintained exchanges of experts with organisations in France, Spain and Italy.

EUREKA Projects

ISEI has continued collaboration with the FORMEN-TOR project (Eureka#19) with partners from France

and Norway. The aim of this project is to develop a decision support system for operators of complex hazardous plants. Two pilot applications were launched. One is called the Satellite Pilot Application and it is concerned with ground manipulation of a cryostat for use in a satellite. The other is termed the Chemical Plant Application and is concerned with the control of a butadiene extraction distillation plant.

Special Commission Projects

The task under this heading is the EQHHPP project: The Euro-Quebec Hydro-Hydrogen Pilot Project. It is a 100MW pilot plant, the aim of which is to demonstrate the provision of clean and renewable primary energy in the form of Quebec hydropower, converted by electrolysis into hydrogen and shipped to Europe, where it is stored and used in diverse ways, e.g. co-generation of heat and electricity, fuel cell operation, production of drinking water and vehicle and aircraft propulsion. The ISEI acts as the project coordinator.

Large Installations and Services

The Institute runs a number of services of general interest, which provide a common operational infrastructure for the benefit of the JRC as a whole. There are six such services:

- Informatics services: as the result of a joint effort between users and service providers a paper called "JRC Informatics 2000" was produced, the objective of which was to make a measurable

improvement to the quality and efficiency of in-house information technology, both now and also in the future. The service is also involved in activities related to the development of new services, analysis and improvement of existing ones, analysis of both market trends and customer requirements.

- ESTI (European Solar Test Installation): the facilities of this laboratory are used to develop methods and equipment for tests on photovoltaic cells, modules and systems. Tests are mainly on request from industry or as a result of collaboration exercises. The major use was in the calibration and qualification of commercial photovoltaic products.

- STRIKE (Structural Reliability Investigation by Knowledge Engineering): this is a well equipped laboratory which has two experimental facilities viz. a pressure vessel test rig for use in fatigue measurements and a Thermal Shock set up where fully automatic, repetitive thermal shock or fatigue tests can be carried out.

- Pulsed Wave Laboratory: where high resolution, non-contact laser measurements can be made.

- General Design Office (B.E.G.): this office carries out a range of design activities, using the latest computer aided techniques. They also provide support in the form of thermodynamic calculations and finite element stress analysis.

- TELEMAC Laboratory: it is dedicated to the design, reliability analysis and testing of remote handling equipment, and to the validation of numerical simulation results by experiments on mockups. Most of the work has been in the fusion field.

2 SPECIFIC PROGRAMMES

Reactor Safety

Safeguards and Fissile Materials Management

Industrial Hazards

Reference Methods for Non-Nuclear Energies

Reliability of Structures

Fusion Technology and Safety

In the following the contributions of ISEI to the Specific Research Programmes of the Commission of the European Communities will be described.

Work under this heading was in the areas of:

a) Reactor safety,

b) Safeguards & Fissile Material Management,

c) Industrial Hazards,

d) Non-Nuclear Energy Reference Methods,

e) Structural Reliability and

f) Fusion.

In the field of Reactor Safety the Institute maintains several data bases which are freely available to other site Institutes and data analysis on topics of interest to plant safety is actively being pursued, as is further development of the System Response Analyser. All the data from the LOBI experiment has been transferred from the now defunct JRC mainframe to minicomputers.

Under title b) a new nuclear fuel cycle database has been set up in addition to another which deals with safeguards R&D activities. Development of evaluation tools for statistical analysis of accountancy data of nuclear materials and for evaluating the results of volume and mass determination in liquid tanks has continued along with surveillance techniques for remote verification in storage areas.

In the industrial hazards field, further progress has been made in the FIRES experiment, Human Factors in Risk Prevention, Decision Support Systems for Environmental Management, Risk Communication and the STARS project.

Concerning non nuclear energy, the work was mainly in the field of photovoltaic cells, with emphasis on the development of testing methods.

Under structural reliability, the main effort was devoted to the reliability modelling of structures and to data treatment from the Reaction Wall experiment.

In the fusion field the three main areas of activity were in support to NET, to JET and long term studies on Low Activation Materials for possible future use in fusion reactors.

2 SPECIFIC PROGRAMMES

Data Acquisition and Analysis

Component Event Data Bank

This centralised data bank continued to increase its content /1/2/ up to the end of December 1991. In its proposal of specific programmes for 1992-94, the Commission has not planned to continue to support the operation of this data bank. As a consequence CEDB officially ceased its life at the end of 1991.

As to the conservation and future use of the data stored in the data base, the following agreement was reached during the last Meeting of the CEDB Steering Committee, held on 18-19th November 1991 at the JRC Ispra:

- ISEI will distribute to all members of the CEDB Steering Committee (S.C.) a copy of the data files stored in the CEDB at the end 1991. The use of these data files is bound by the confidentiality rules specified in the document "Rules for CEDB operation". No commercial use is allowed for the time being.

- ISEI will continue, in the frame of its 1992-1994 programme, to perform prototypical analyses of the data sets in order to estimate reliability parameters. The results will be distributed to the other Steering Committee Members.

Analyses are expected to be performed also by the latter and the results will be communicated to all S.C. Members. Members of the S.C. are the data suppliers (the owners of the data) and ISEI. By this agreement, ISEI continues to have the right to use CEDB data for research purposes.

Methods for failure rate estimation and comparison between data coming from different plants

The major difficulty in the use of reliability event data bases for estimation and comparisons between different suppliers (testing) arises from the multi-dimensionality of data base data and the consequent data sparsity. These are addressed by the use of "intelligent selections" on the database and appropriate bayesian statistics.

"Intelligent selections" eliminate a small fraction of data where most data heterogeneities lie and produce a relatively small number of samples where estimation and testing is to be consequently carried out. Such selections have been carried out for the definition of stratifications/taxonomies for electric motors stored in the CEDB /4/5/.

Parametric and non-parametric methods have been carried out to compare component failure rates for different suppliers (or different samples in general). Non-parametric methods /6/ account for population variability between components but when based on the classical estimators for individual component failure rates they are prone to biases that may be created by systematically different periods of operation of components /7/. A promising way out has been developed in the empirical Bayes framework.

Development of Reliability Databases

Mechanical Valve Reliability Study

The initiative of developing a data base of reliability parameters on mechanical valves was suggested in the framework of the EuReDatA executive committee. Seven member Organisations (ISEI-SER among them) agreed to finance the project and to supply reliability parameters on mechanical valves derived from their in-house data banks (from the CEDB in the case of ISEI-SER). One aim of the study was to show the possibility of realising an exchange of component reliability data among different Organisations at the European level . The final product of the study is a report, the second part of which is a Reliability Data Handbook. This handbook, distributed only to the participating Organisations, gives details of the 155 data samples employed in the study and the results of the analyses. The reliability data (processed by means of the software HARIS - Hazard and Reliability Information System, developed by RM Consultants Ltd) constitute, now, a database which can be installed on PCs.

EIREDA - European Industry Reliability Data Handbook, Vol. 1, Electrical Power Plants

It is the result of a collaboration between EdF and ISEI, an initiative launched in the framework of the activities of EuReDatA. The Handbook was edited

under the sponsorship of ISEI. The aim of EIREDA is to represent a first step towards the creation of a multi-industry reliability databank specific to European manufacturers, operators and users. The sources of the reliability parameters are:

- the Probabilistic Safety Assessment of an EDF 1300 Mwe NPP, document now publicly available in France,

- parameters derived from the JRC Component Event Data Bank - CEDB,

- literature collections of reliability parameters.

Acquisition and Maintenance of Nuclear Reactor Data Bases

The data bases described below are freely available to other Institutes of the JRC.

IRS - Incident Reporting System

This system is managed by the Organisation for Economic Cooperation and Development - Nuclear Energy Agency (OECD/NEA); it was created with the purpose of collecting, assessing and disseminating information on safety-significant plant events occurred in Nuclear Power Plants operated in member Countries. Some Countries contribute to IRS via the International Agency for Atomic Energy (IAEA), Vienna (A). Parts of the reports are stored in a database and diskettes are distributed every three month to all National Coordinators and Observers. The status of the IRS Database as of end October 1991 is given in /3/.

NUCLAAR - Nuclear Computerised Library for Assessing Reactor Reliability

This system was developed by the U.S. Nuclear Regulatory Commission (NRC) and is managed by the Idaho National Engineering Laboratories (INEL). NUCLAAR is an automated data base management system used to process, store, and retrieve human and equipment reliability data in a ready-to-use format. The current version is 2.0, release 1.0.

MicroPRIS - Power Reactor Information System

This software for PC users is a version of the Power Reactor Information System managed by the International Atomic Energy Agency of Vienna (A). PRIS gives worldwide information on power reactors in operation, under construction, planned or shutdown, and data on operating experience with nuclear power plants in IAEA Member States.

References

/1/ BALESTRERI, S., CARNEVALI, C. - "CEDB, Status of the bank as of November 1991" WP ISEI/SER2163/91 (1991)

/2/ GOW, H.B.F. - "Summary of the 9th Meeting of the Steering Committee of the CEDB Data Suppliers", Tech. Note No 1.92.08, WP ISEI/SER2173/92; CEC-JRC Ispra (I), November 18-19 (1991)

/3/ BALESTRERI, S., CARNEVALI, C. - "IRS Incident Reporting System, Status of the system at October 1991", WP ISEI/SER2142/91 (1991)

/4/ ARSENIS, S.P. - "On the Performance of Different Sets of ELMOs in the CEDB with Particular Reference to ENEL ELMOs. Part I. Data Validation and Stratification via Intelligent Selections" - Technical Note 1.91.34, JRC (1991)

/5/ ARSENIS, S.P. - "Intelligent Selections for the Statistical Analysis of Reliability Database Data". Accepted and to appear, Proceedings of the 1992 European Safety and Reliability Conference, Elsevier, England.

/6/ ARSENIS, S.P. - "On the Performance of Different Sets of ELMOs in the CEDB with Particular Reference to ENEL ELMOs. Part II. Testing for Heterogeneities of Classical Estimates of Failure Rates within Component Strata" - Technical Note 1.91.44, JRC (1991)

/7/ ARSENIS, S.P. - "Assessment of Performance of ENEL ELMOs vs. Other ELMOs in CEDB. Testing for Homogeneities in the Classical Framework" - Technical Note 1.91.112, JRC (1991)

Man-Machine Interaction Studies: the System Response Analyser (SRA)

The System Response Analyser (SRA) is a simulation tool for the study of the dynamic interaction of humans and machines. The SRA is based on three main components, namely the driver of SRA (the DYLAM code), the machine model and the operator model. The integrated simulation of the man-machine-environment, as proposed in the SRA, may help to improve the safety of systems and can be used to design operational and emergency procedures.

In the course of 1991 a new probabilistic algorithm of the DYLAM-3 code was completed and a set of studies was started in order to validate the code with reference to a sample significant dynamic system. *Fig. 2.1* shows the comparison of the probability density function of the top event obtained by means of DYLAM (dashed line) and by a Monte Carlo code (solid line). Moreover, an application of the SRA concept to the Chemical and Volume Control System of a PWR was presented.

Concerning the physical modelling of plants, an activity was started to couple the DYLAM code with the TRETA simulation package in the frame of a cooperation between ISEI and Consejo de Securidad Nuclear (CSN), the Spanish Nuclear Safety Authority.
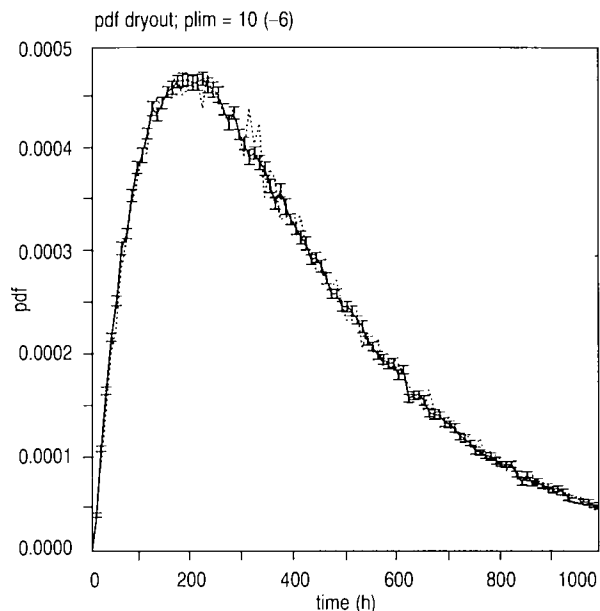
pdf dryout; plim = 10 (-6)

Fig. 2.1: Comparison of probability density function (pdf) obtained with DYLAM and with Monte Carlo approach.

The human behaviour modelling activity was concentrated on the analysis of methodological aspects of Human Reliability (HR) and on a preliminary application of a dynamic approach to the HR problem /2/3/. A training simulator of a nuclear reactor, the SGHWR located in Winfrith, was utilised to extract part of the expertise of the control room operators /4/.

References

/1/ CACCIABUE, P.C., CARPIGNANO, A., COJAZZI, G. - Dynamic Reliability Analysis by DYLAM Methodology: the Case Study of the CVCS of a PWR. Proceedings of International Conference on Probabilistic Safety Assessment and Management. Beverly Hills, California. 4-7 February 1991. Elsevier, New York, NY (1991)

/2/ CACCIABUE, P.C., VIVALDA, C. - A Dynamic Methodology for Evaluating Human Error Probabilities.Proceedings of International Conference on Probabilistic Safety Assessment and Management. Beverly Hills, California, 4-7 February 1991. Elsevier New York, NY (1991)

/3/ CACCIABUE, P.C., COJAZZI, G. - Using MMI Simulation for Improving Human Reliability and Operators' ability to run Complex Systems. Workshop on Control of Safety, Bad Homburg , 2-4 May 1991 (1991)

/4/ COJAZZI, G., LOCKETT, J.A., WHEATLEY, K.H. - Training Simulators as a Tool for Eliciting Plant Operators Knowledge: the Winfrith Experiment. IAEA Specialist meeting on Training Simulators for Safe Operation in Nuclear Power Plants, 24-27 September 1991, Balatonfured, Hungary (1991)

Experiment automation in LOBI

The ISEI contribution to the experiment LOBI in recent years has been concentrated both on the development of hardware and software and on the operation of the equipment during tests. All tests were supported in the areas of computer control, data acquisition, on-line data analysis and electronic instrumentation.

Work was carried out in the following areas amongst others:

– Programming of the LOCAM system for direct computer control.

– Operation of Exatest system (Density Measurement Instrumentation).

– Development of dedicated hardware and software for automation.

– Data correction, calibration and plot production on EDF software /1/.

During the year all experiment data since the start of the project was transferred from the Amdahl to mini-computers /2/.

References

/1/ BEST, C., HAMMANS, W. ROEBBELEN, D. - "New data processing software for LOBI. An application of EDF" - Technical Note I.90.24 march 1990

/2/ ROEBBELEN, D. - WRITED and READED a programme system to transfer EDF data between computer operating systems" - Technical Note I .91.39, march 1991
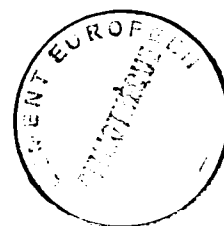
SAFEGUARDS AND FISSILE MATERIALS MANAGEMENT

Integration of Safeguard Techniques

Under the heading "integration", two types of activities are performed. The first type concerns the analysis of the European nuclear fuel cycle and of the R&D Safeguards activities of organisations in EC. It also includes the management of ESARDA (European Safeguards Research and Development Association). The second type of activity is related to the development of evaluation tools for the statistical analysis of accountancy data of nuclear materials and for the evaluation of the results of volume and mass determination in liquid tanks.

Fuel Cycle Analysis

An EC nuclear fuel cycle data base on existing and future facilities, has been established and is regularly updated. This data base is used for analysing important safeguards features in relation to the evolution of the EC fuel cycle in view of defining R/D needs. During 1991, a special effort was dedicated to a review of the data from power reactors.

Analysis of R and D Activities

ISEI has established, on request of ESARDA and in cooperation with other partners, a data base for EC safeguards R/D activities. Some categories of these R/D activities have been critically analysed, namely those related to containment and surveillance techniques and to reprocessing plant safeguards. The results of the analysis are to be published in 1992. The regular monitoring and analysis of the R/D activities is an important basis for improving cooperation with other organisations or orienting the ISEI R & D work.

Management of ESARDA

ISEI is actively involved in the management of the European Safeguards Research and Development Association, which presently includes all EC organisations active in Safeguards R/D and major plant operators. The management consists of:

- assuring the secretariat of the Association and of the Steering Committee, Board and Coordinators' Committee;

- organising the general annual meeting;
- Publication of the ESARDA Bulletin. In 1991 the annual symposium was held in Avignon (May 14-16) and was hosted by CEA. The symposium was attended by about 220 persons worldwide and about 130 papers were presented. The proceedings were edited soon after the meeting. Two ESARDA bulletins were prepared during 1991.

Safeguards Systems Analyser (SSA)

A new version of SSA has been studied. SSA is a statistical accountancy programme for the statistical analysis of nuclear material accountancy data. The programme is intended as a tool for the evaluation of error components from measurements, for different categories of nuclear materials in bulk handling facilities. The programme is to be used namely for parametric studies on the distribution of measurement errors.

The new version of the SSA is being implemented on a dBase III DBMS and related language and new statistical algorithms have also been introduced. The first validation tests of the programme are being performed on material balance data from LEU fuel fabrication plant.

Mass and Volume Measurements

The uncertainty in the determination of the mass of nuclear materials in liquid tanks is a key component to be considered in the overall material balance evaluation for reprocessing plants.

The GNS in Germany has performed, in cooperation with many other organisations in 1988-1989, a measurement evaluation exercise (in cold conditions) on a large $12m^3$ annular input accountancy tank, which was to be installed at Wackersdorf. The detailed analysis of the measurement results is now underway in ISEI. The facility used for the above mentioned evaluation programme has been transferred to the ISEI, and the establishment of a Tank Measurement (TAME) laboratory, with a wider objective, is now being studied, also including tanks for output

solutions and buffer tanks. This activity is a joint research between the Institutes of ISEI and IST.

Many contacts have been established with reprocessing plant operators, reprocessing plant technology holders and designers, R/D organisations, and Safeguards Authorities to define the final layout of TAME and the guidelines for the experimental programme which is expected to start by the end of 1992.

Surveillance and Teleoperation

The objective of the work is the development of surveillance techniques and computer aided teleoperation applied to the remote verification in storage areas.

Computer Aided Teleoperation for remote verification

The aim of this project is to explore the use of teleoperation techniques for the remote verification of storage and inventory of fissile materials. The system consists of two main components: a vehicle carrying on board a manipulator arm and sensors (TV cameras, Laser Range Finder), and the systems operator console /1/. Special attention is given to both the man-machine interface as well as to Safeguards considerations. The work progressed thus:

Laser Range Finder

Some work was done for range image processing and interpretation. Several algorithms for the edge segmentation were tested under noise /2/. Recently, the first range images from real environments have been obtained (Fig. 2.2). Current work investigates the best approach for the segmentation of range images:

− regions from edges (a region is characterised by delimiting edges)

− edges from regions (edges are the frontiers between two regions)

Vehicle Navigation and User Interface

An important aspect of the final system is the systems operator interface. All relevant information must be available to the operator, without overloading the operator with unnecessary data. The interface was designed such that it is up to the systems operator to select at any moment what is needed and what is not. Different modules were designed, in particular
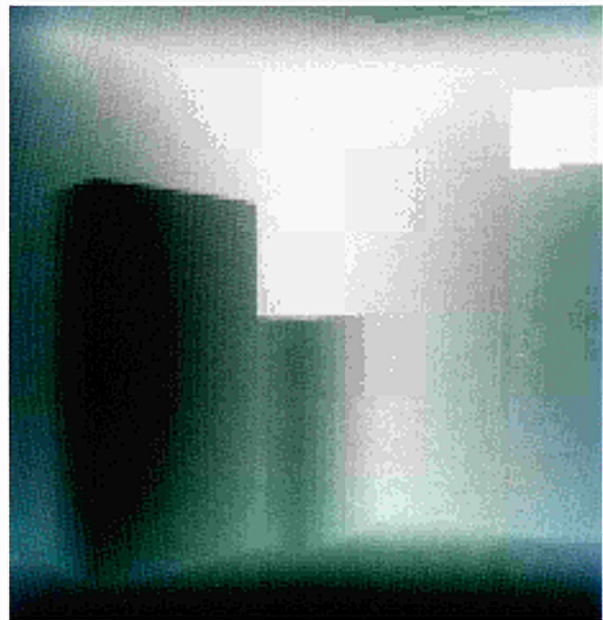

Fig. 2.2: Image acquired from laser range finder

the room map displaying an animated view of the position of the vehicle /3/. An extra module was designed to provide 3D animated graphical visual information of the vehicle inside the storage area.

The presentation of TV images in the operators console is an important tool for the navigation /4/. The whole system for the presentation of TV pictures on the operators console has been completely redesigned. New hardware has been chosen allowing the presentation of quasi-live pictures (b/w and colour) on the screen (between 6 and 10 b/w images per second). The software interface is being rewritten to allow for contrast and brightness control, as well as for simple grey level transformations (histogram equalisation, contrast stretching, etc...).

Zoom and Focus Control

The TV cameras on board of the vehicle have lenses with auto-iris and motorised zoom and focus. The hardware and software interfaces for the manual control of zoom and focus were designed and implemented. They are part of the general interface for the presentation of TV pictures on the operators console. Another feature that was implemented is the software for keeping the TV images always on focus. This software can run as a background task, alleviating the operators burden.

Pan and Tilt Units

The electronic circuits for motor control and absolute angular position feedback have been designed. These interfaces incorporate both analog-to-digital and digital-to-analog converters. Pan and tilt control (hardware interface and control software) has recently migrated from the PC environment, where it was initially implemented, to the target computer on board of the vehicle (a 68020 VME computer running a real-time operating system). The same changes were made to the zoom and focus control software.

Manipulating arm

The existing manipulating arm is a small one with six degrees of freedom. Its control will be made via a Spaceball controlled by the operator also with six degrees of freedom. Work on the interface between the Space-Ball and the manipulator has started (Fig. 2.3). The aim is to control the tip of the manipulator with the SpaceBall, using the inverse kynematics model of the arm. The type of control, e.g., speed or position control, needs to be further investigated.

Another aspect that needs a thorough study is the computational complexity of the inverse kynematics model, and its influence on the real-time performance of the arm, and its ease of use.

Systems Integration

Systems integration can be seen from two perspectives: the choice of the hardware and software envi-
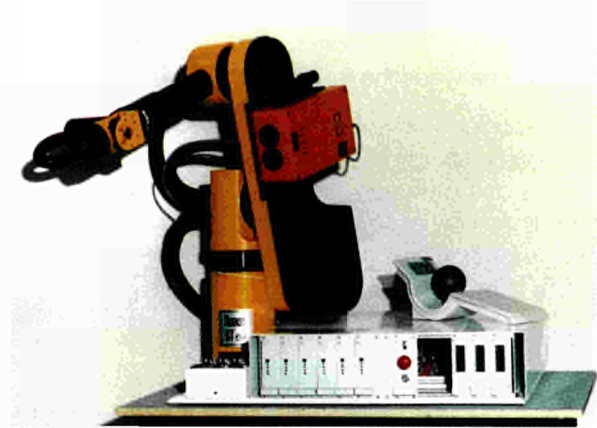

Fig. 2.3: View of manipulator arm with laser range finder and Space Ball.

ronments on top of which the whole system is built, and the actual assembly of the functional modules, that had been developed on a stand-alone basis, into a complete system (Fig. 2.4).

At the moment, a UNIX workstation is used, and all user interfaces are built on top of X-Windows and Motif. Most stand-alone functional modules have been developed in a PC environment. At a later stage, these modules migrate to their target environments: UNIX for users interface software, and 68020 for all the tasks with real-time requirements. Particular attention has been given to the choice of the development environment, in order not to have vendor dependent solutions.
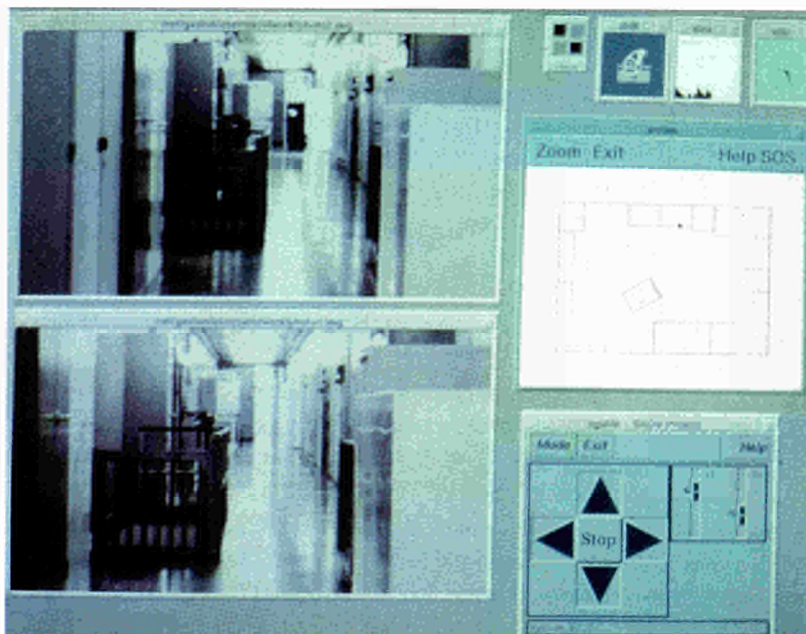
Integrated Surveillance Systems

Different research and development is going on in the safeguards community in the areas of recording surveillance data, back-end processing of video pictures in the review process and front-end processing for data reduction. The increasing use of multi-camera systems and additional C/S devices requires integrated surveillance systems combining the functions of different precedent systems. This year ISEI started two

Fig. 2.4: Integration of different information into a single display

projects in this area. The first consists in combining the CAVIS system /5/ with the scene change detector Polyline /6/ using a master-slave configuration of both computers. This solution will allow the integration of the recording, auto-di agnostic and back-end processing functions in one system. The second project aims to apply the scene change detection method to multi-camera systems for front-end processing. These developments are under way and will be completed in 1992.

Image Correlator

A good method for detecting scene changes in surveillance pictures consists in correlating successive images in a video sequence. Illumination variations and noise from TV camera do not affect significantly the cross-correlation factor. However, a large number of mathematical operations have to be performed which reduce the execution speed of this method. Therefore a application specific integrated circuit (ASIC) has been developed for this mathematical operation. It is based on gate array technology and comprises 8300 gates. This year both the controller for the chip and the interface to the PC computer bus have been implemented /7/. The controller consists in a finite state machine (FSM) which generates all control signals to the correlation chip. The software used to design the FSM was FutureNet and Xilinx. The interface developed to the computer bus operates in DMA master mode. The complete correlation board for PC-AT computer has been installed and tested successfully (Fig. 2.5).

Sealing and Identification Techniques

Two techniques are studied for the sealing of nuclear containers or for the unique identification of nuclear materials items: the verification of the surface configuration of items or the use of ultrasonic signatures given by defects randomly distributed into solid bodies.

Feasibility studies have been conducted to investigate the respective benefits of techniques using mechanical or laser sensors for the surface topography measurements on fuel pins, containers with reference materials or tagging devices. The reproducibility of such measurements strongly depends on the good repositioning of the sensor with respect to the surface being measured. It has been shown with prototypes from the industry that the laser technique is
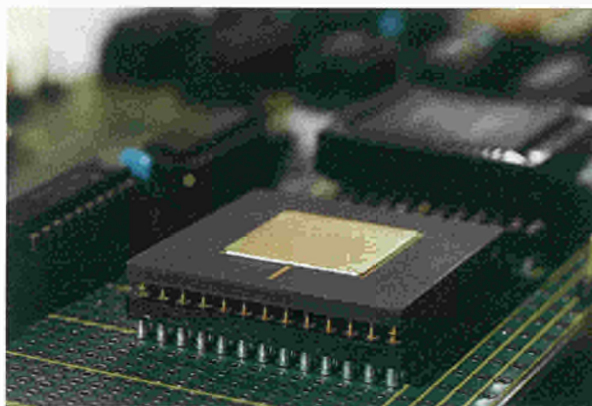

Fig. 2.5: View of image correlation board with ASIC chip.

not yet precise enough to supersede a mechanical device controlled by an ad hoc ISEI software.

As to the ultrasonic techniques which are involved in seals and tags, the development for the comparison of signature algorithms has been the subject of a large effort since they are the basis for fast verification of a safeguarded item. Such an algorithm and related software has been offered for introduction in routine use and is being tested on a PC based inspector verification equipment.

Consideration has been given to alternative solutions to produce stable built-in random defects in non-metallic matrix. Samples were obtained which could be read with the same reading equipment and analysed with the same algorithm in use for random cavities in metallic structures.

Containment and Surveillance Performance Evaluation

Many C/S devices and systems have been developed over the years and an increased use is made of them by inspectors. In order to evaluate in a systematic way the performances of the C/S devices and measurement instruments, a special laboratory has been constructed (called LaSCo), where environmental and mechanical tests can be performed.

A model storage facility has been installed in LaSCo in order to demonstrate and test sealing and surveillance devices under realistic conditions. Furthermore climatic chambers and vibration test equipment have been installed. Systematic testing is expected to start during 1992.

References

/1/ GONCALVES, J., et al. - "Computer aided teleoperation applied to safeguards", Proc. INMM, Los Angeles, July 1990

/2/ CAMPOS, G., et al. - "Range image segmentation", Proc. RECPAD 90, Lisbon, March 1990

/3/ VEIGA, P., et al. - "A man-machine interface for a tele-operated vehicle", Proc. IEEE Melecon, Ljubljana, May 1991

/4/ GONCALVES, J., et al. - "Navigation of a tele-operated vehicle in a safeguards environment", 11th ESARDA symposium, Avignon, May 1991

/5/ BETTENDROFFER, E., et al. - "CAVIS-2 Computer aided video surveillance system", technical note n. I.91.90, July 1991

/6/ MOL, M. - "Image processing methods for scene change detection and motion detection", ESARDA bulletin, May 1991

/7/ SANTOS, V. - "Image correlation board for PC-AT computer based on VLSI circuits", grant report, September 1991

Non Destructive Analysis of Fissile Materials

Adaptation of the MONTE CARLO code MCNP to run on i860 CPU

MCNP is the Los Alamos "Monte Carlo Neutron Photon" code, written in Fortran 77. This code runs on the JRC main frame and is much used to investigate the "Phonid" device, which is the instrument constructed by JRC Ispra for Euratom inspectors to verify the content of U235 and Plutonium in fabrication plants inventories.

Work has been done to port MCNP to the INTEL i860 CPU. A commercial product is used, where this CPU, together with 8 MBytes of memory is installed on a PC plug-in board. The NDP-860 Fortran compiler, the linker and the assembler run on the i860. The Fortran programme is loaded under MS-DOS

The main difficulties experienced so far are:

- Bad or no compiler documentation

- Compiler errors

- Compiler restrictions

- Handing a programme with of 30.000 lines of source code with editors on a PC.

The first phase of this work has been achieved. The code is now adapted to run on the i840 CPU under the operating system MS-DOS, which is used for handling of keyboard, monitor, disk and clock services.

The processing speed, which is obtained with an i860 CPU, 40MHz clock rate, corresponds to half of the processing speed of the JRC main frame.

MCNP code for the i860 CPU goes now the Beta-Test phase. Test cases processed so far show results, which coincide with results obtained from main frame runs. Cost reduction will be extraordinary, when the Phonid work is moved from the main frame to a i860 enhanced PC.

INDUSTRIAL HAZARDS

Data storing in FIRES experiment

A general system for storing experiment data and calculated data has been developed. This is called the EDF (Experiment Data Files) software /1/. This system has been adopted by the IST for several experiments. It is a software package which provides users with an easy to use interface library. In addition several application programmes have been written for general purpose use.

These are:

- A database interrogation programme

- A graphical display programme
- A data manipulation and signal processing programme.

The EDF system has been implemented for VMS and UNIX platforms. Software has been implemented which allows to transfer data from the VAX/VMS database to UNIX database. In this way all experimental data stored on the VMS implementation is now accessible from UNIX workstations /2/.

Data from the first experiments of FIRES batch reactor have been stored in the EDF database. Special software to transfer data has been written.

The results of the FIRES simulation code FISIM have been transferred to EDF. This allows comparison between experiments and calculations.

The FIRES process control software has been commissioned, and successfully used during the first experiments of the facility. This software has been modified and extended to allow more general data acquisition. The commissioning covered the interlock system, the IDBS data base and batch RICETTA software to control experiments.

The graphical results (see *Fig. 2.6*) from the initial tests were produced using EDF developed tools /3/.

References

/1/ BEST, C. - "Experiments Data Files. A General System for Storing Data from Experiments" - Technical Note I.90.96, October 1990

/2/ BEST, C. - "EDBTOP and EDBMON. Two X-Window client programmes for the Experiment (EDF) database", in print

/3/ ROEBBELEN, D. - "PLLIB - A Library to Perform Scaling and Axes for 2D X/Y Plots", - Technical Note I.90.15, February 1990

Risk Assessment in Emergency Situations

The development of the computer code system EMERGENCY was started in 1989 with the objective of constructing a real-time risk assessment concerning an accidental release of chemically reacting substan-

ces from an industrial facility. EMERGENCY endorses a plant-specific emergency strategy by making allowance for both the site (micro-meteorology, topography, surface structure etc.) and for the behaviour of the chemicals during their dispersion in the atmosphere.

EMERGENCY consists of four modules simulating

• the 3-D mass-consistent windfield

• the local turbulences induced by buildings etc.

• the dispersion of airbornes

• the modification of ambient air flow by large-scale spills of a hazardous gas-cloud being, initially, denser than air.

The numerical treatment of the events is based upon an intermittent turbulence model /1/ which describes both turbulent air flow and pollutant transport by two classes of interacting eddies of different sizes and finite lifetimes.

Three approaches are used:

• An eulerian dispersion model (MIXAGE /2/) characterised by a system of stochastic differential equations being solved by operator-splitting techniques.

• A lagrangean random paths model (PLUME /3/) - taking into account local turbulences and complex boundary conditions imposed by micro-meteorology, terrain and structures - furnishes dispersion parameters required by MIXAGE.

• A combination of MIXAGE and PLUME treats the dense gas phase dominating the gas release and early dispersion period. A comparison of the results with those obtained by computer code ADREA-HF /4/ is in preparation.

The results obtained in 1991 demonstrate the feasibility of a computerised real-time risk assessment for an accidental release of toxic gases, when running a strongly parallised version of EMERGENCY on a transputer system like T-NODE.
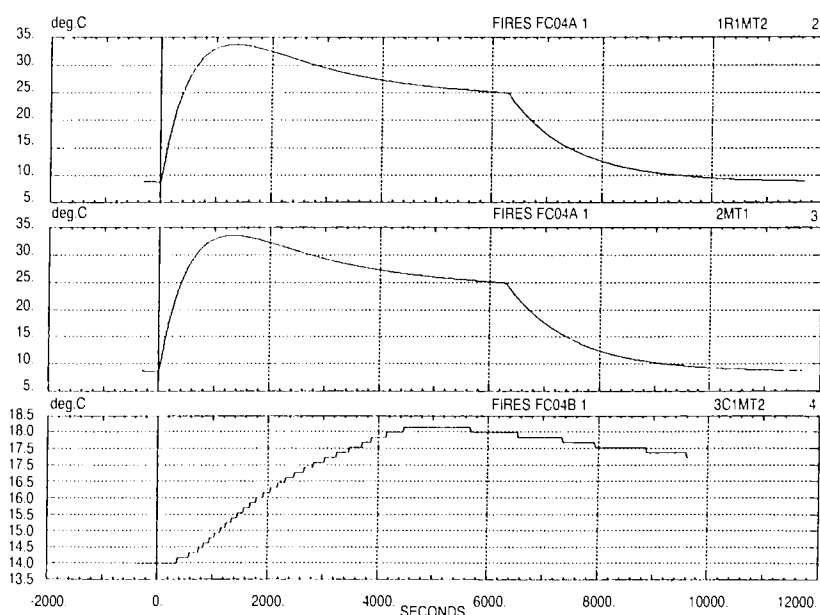

Fig. 2.6: Plot example of FIRES data.

References

/1/ EUR-TN 1.89.130 (1989)

/2/ Comp. Phys. Comm. 46 (1987), 351 EDF-Bulletin D.E.R. Série C 1 (1990)

/3/ Appl. Math. Modelling 11 (1987), 110

/4/ EUR 13580 EN (1991).

Human Factors in High Risk Prevention

Research on Human Factors in high risk prevention has followed three main directions, namely: Cognitive Simulation for Man Machine Interaction (MMI) studies, Cognitive Ergonomics in complex Working Environments and Process Diagnostics for early fault detection and diagnosis in accident management.

Cognitive Simulation

The first activity on cognitive simulation concerned the development of the Cognitive Simulation Model, COSIMO, in conjunction with the contract Research related to the Esprit II Basic Research Project MOHAWC. The model COSIMO aims at the simulation of the decision and action processes of operators in complex working environments. The model is based on psychological theories of cognition, it is implemented in a Blackboard software architecture and it is programmed in Lisp (Fig. 2.7) /7/. As basic research on COSIMO, a number of possible applications and developments have been explored by theoretical analyses /4/5/, by field applications /3/

and by studies of Artificial Intelligence architectures /6/.

The second activity concerned the contribution to the STEP Project PL 900580: System Response Generator (SRG). The SRG is a software tool, which can be used to analyse the influence of human decision making and action on the way in which system accidents evolve. The SRG can be used:

- to identify the aspects of the task and the Human-Computer Interaction (HCI) where problems are likely to occur,
- to provide data as input to a more formal Probabilistic Safety Analysis (PSA) or Human Reliability Analysis (HRA), and
- to evaluate the effects of specific modifications to the system (e.g., of procedures, information presentation, control options, etc.).

Two main actions were carried out: the development of software requirements for the SRG and the demonstration of SRG functionality in the avionics domain.

Cognitive Ergonomics

The work in the area of cognitive ergonomics has covered a number of studies performed partly as Framework Programme research and partly as Contract Research. In particular, the latter have concerned the field study on the behaviour of the operators of a nuclear power plant, funded by AEA Winfrith (UK), and the research on the effects of "stress" in complex working environment, funded by the CNR Roma (Italy).
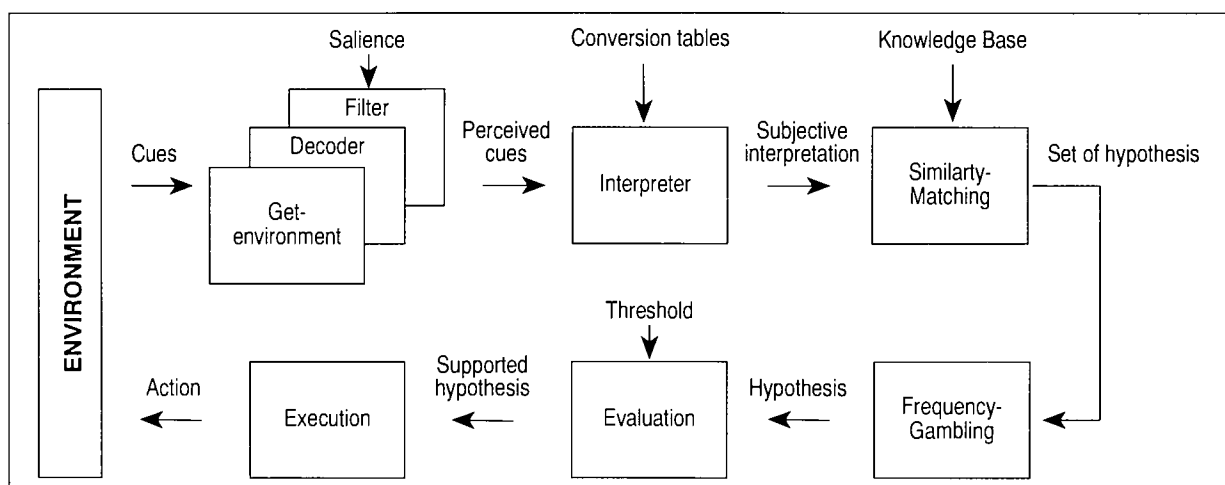

Fig. 2.7: The Architecture of the Model COSIMO.

As far as the Framework Programme research is concerned, the crucial aspect of dynamic man-machine interaction, i.e. the tuning between the operator and the system /2/3/, has been analysed in the working environment of a blast furnace of a steel and iron factory. The research focused on:

- the description of what operators do when controlling the stop task of the blast furnace;

- the identification of cognitive processes by which the operators apprehend the dynamicity of the blast furnace;

- the analysis of the temporal dimension of human error. Fourteen operators participated in the experiments. Current techniques of observation and of protocol analysis have been employed for exploring cognitive processes. Moreover results allowed to formulate some specifications for improving human errors predictions and for design of decision support systems.

Process Diagnostics

The project refers to the development of a diagnostics methodology for the integration of stochastic modelling and simulation with cognitive engineering techniques for Man Machine Interaction. In particular, it focuses on the following steps:

- Formulation of a coherent framework for diagnostics and decision support systems in the management and safety of technological processes.

- Choice of statistical models and methods for diagnostics tasks in technology.

- Design and realisation of automatic diagnostics modules as "Automatic Diagnosticians".

The proposed methodology follows the philosophy of the "black box" approach: the physical model of the system is ignored because the system response is analysed and diagnosed as the realisation of a stochastic process. The parameters of the system model, or else its transfer function, are estimated by means of an identification procedure using the signals emitted by the system (trajectory analysis) /1/.

The diagnosis methodology profits of a set of statistical tests which are very sensitive to changes in the trajectories of the actual responses with respect to the standard working conditions /7/. Fig. 2.8 shows the "Diagnostics Chart" resulting from the test on a trajectory change due to the "rupture" of the model parameters, i.e. the departure of the actual response model from the standard one.

The results of the activity, with reference to the goals to be obtained in this project, concern the Handbook on Process Diagnostics, the relevant Software and some studies on Support Systems.

References

/1/ AGLIARI, A., CALVI PARISETTI, C., OLIVI, L., PESARIN, F. - Combination of Several Expert Information Sources in the Context of Linear Models. Fourth Valencia International Meeting on Bayesian Statistics. Peniscola, April 15-20, 1991 (1991)

/2/ DECORTIS, F., CACCIABUE P.C. - Modéllisation Cognitive et Analyse de l'Activiti. In R. Amalberti, M. de Montmollin (Eds.), Mochles et Pratiques de l'analyse du travail, 85-118 Mardaga, Bruxelles (1991)
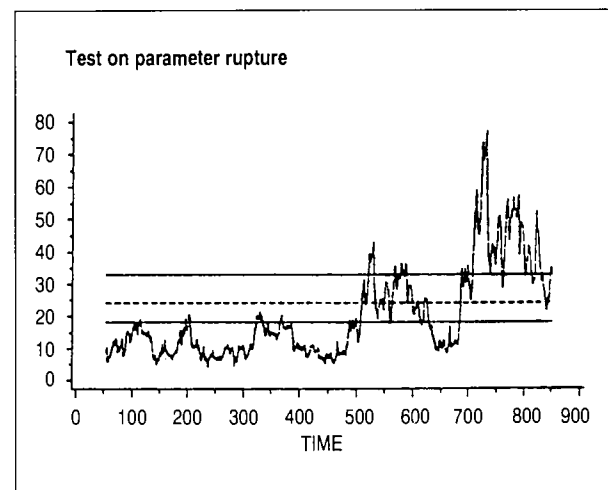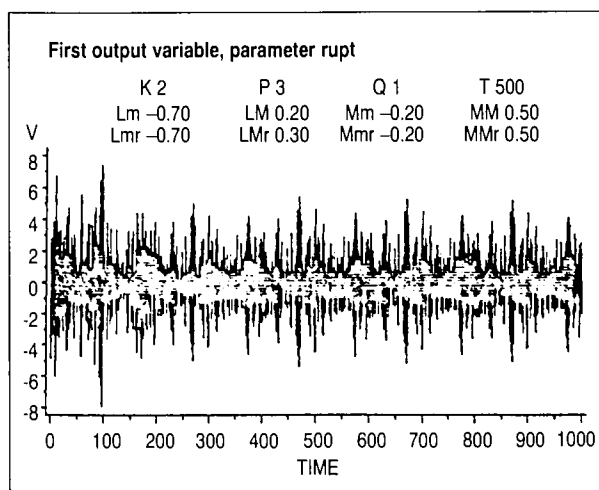
Fig. 2.8: The Diagnostic Chart.

/3/ DECORTIS, F., DE KEYSER, V., CACCIABUE, P.C., VOLTA, G. - Temporal Dimension of Man-Machine Interaction. In G.R.S. Weir and J. Alty (Eds.), HCI and Complex Systems, 51-72 Academic Press, London, UK (1991)

/4/ CACCIABUE, P.C., DECORTIS, F., MASSON, M., NORDVIK, J.P. - Cognitive Modelling as Simulation Technique for the Development of Intelligent User Interfaces. In A. Life, C. Narborough-Hall, I. Hamilton (Eds.), Simulation and the User Interface, 91-102 Taylor & Francis, London, UK (1991)

/5/ KJAER-HANSEN, J., CACCIABUE, P.C., DROZDOWICZ, B. A Framework for Cognitive Simulation. Presented at workshop on Cognitive Approaches in Dynamic Environments. Paris, 13 - 14 June (1991)

/6/ KJAER-HANSEN, J. (1991).Decision Structures of Multi-agent Systems. Ph. D. dissertation. Institute of Automatic Control Systems, Technical University of Denmark, October.

/7/ LESSI, O., OLIVI L., PARISI, P. - Fault Detection and Diagnosis in Linear Systems. IFAC/IMACS SYMPOSIUM on Fault detection, Supervision and Safety for Technical Processes, SAFEPROCESS '91, 109-114. Baden-Baden, Germany. Sept 10-13, 1991

Decision Support Systems for Environmental Management

The institutional tasks of the European Commission include regulatory and promotional activities on matters at the interface between science, technology and society.

In this frame various Decision Support Systems (DSS) have been implemented by using the Multiple Criteria Decision-Aid (MCDA) approaches for Environmental Management (EM) applications. Examples of these applications include transportation of hazardous materials, management of environmental resources (e.g. water), and industrial waste disposal. The development of these DSS is clarifying and supporting multi-national Environmental Management processes.

Methodology

The DSS developed are characterised by different approaches to the decision problem taken from the field of Operations Research, and by the integration of heterogeneous modules using appropriate information technologies. These modules include, for example, data bases, static models, dynamic simulation models, interfaces for problem setting, and modules to implement various approaches to decision.

Four reasons have motivated this system methodology. They are: the importance of the stakes involved, the complicated structure of the Environmental Management problems concerned, the absence of overall experts, and the need for adequate justifications of the decisions taken. The use of DSS is therefore proposed as providing direct links between the real environmental problems, interdisciplinary scientists, and the decision makers.

These DSS are structured to address environmental problems by making use of the accumulated scientific and technical knowledge of multidisciplinary groups and teams (biologists, chemists, economists, physicists,computer-scientists, engineers, managers, system analysts, etc). In the field of information management systems this type of DSS has been classified as having the highest level of complexity combined with the highest level of interactivity.

The principle aims of Environmental Management are:

• to reach a compromise between environmental exploitation and environmental quality, and

• to attain and maintain an acceptable level of environmental quality.

The complex Environmental Management problems emerging from mans use of modern technology involve a wide range of disciplines and cannot be assessed on the basis of one criterion of choice. This means solutions cannot be found by the optimisation of a single objective function. Consequently the Multiple Criteria Decision Aid (MCDA) approaches have been chosen as a basis for these DSS, and modern Information Technologies have been adopted to ensure their efficient integration.

Multicriteria Decision Aids Methods (MCDA)

Decision processes involve the use of systematic procedures to evaluate the different efficiencies and relative benefits of alternative solutions, leading the decision maker to rational choices. In Environmental Management applications the problems are characterised by conflicting criteria, possible compromise solutions, and the need to take account of the decision makers preferences. Thus MCDA approaches, which are a set of procedures satisfying these characteristics, are the best adapted to Environmental Management applications. MCDA approaches aim to construct a formal system to aid the decision maker by permitting him to understand, specify and model his preferences. Regarding the Environmental Management applications analysed, the comparison between continuous and discrete MCDA approaches has emerged. For continuous problems, the alternatives (actions) are formulated in a continuous way

(with real values for all variables); that is the parameters may assume all values between the allowed boundaries. Three specific features characterise the continuous MCDA approach: the number of alternatives is in principle infinite; the feasible alternatives are only implicitly defined and not known a priori; the step from an implicit definition to an explicit presentation of alternatives is an important part of the procedure. The discrete MCDA approach involves a finite (normally not very high in number) set of feasible alternatives. Discrete problems are very common in environmental analysis, which in general (but not always) predetermines some well determined alternatives.

In the continuous cases, the Multi Objectives Linear Programming (MOLP) approach has been used for converting the space of continuous actions to the corresponding space of consequences which is, in the cases studied, discrete. The objective functions used in the MOLP approach are all linear functions. The utility function used in the MOLP approach is also a linear function. The space of consequences corresponds to the set of decision value vectors. Following the MOLP approach, either the Aspiration Levels (AL) approach, or the Reference Point approach, which is a particular case of the AL approach, can be used. The AL approach consists of defining an aspiration level (or goal) for each criterion, in order to select the set of good alternatives and its complementary set of bad alternatives. The RP approach, the most frequently used one in the study cases, consists in determining the real point which comes closest to the reference point, which is theoretical. The two steps are the elimination of the dominated points by using the Pareto set, and the determination of the optimal point by using, for example, the Euclidian distance. The reference point approach is illustrated in *Fig. 2.9*.
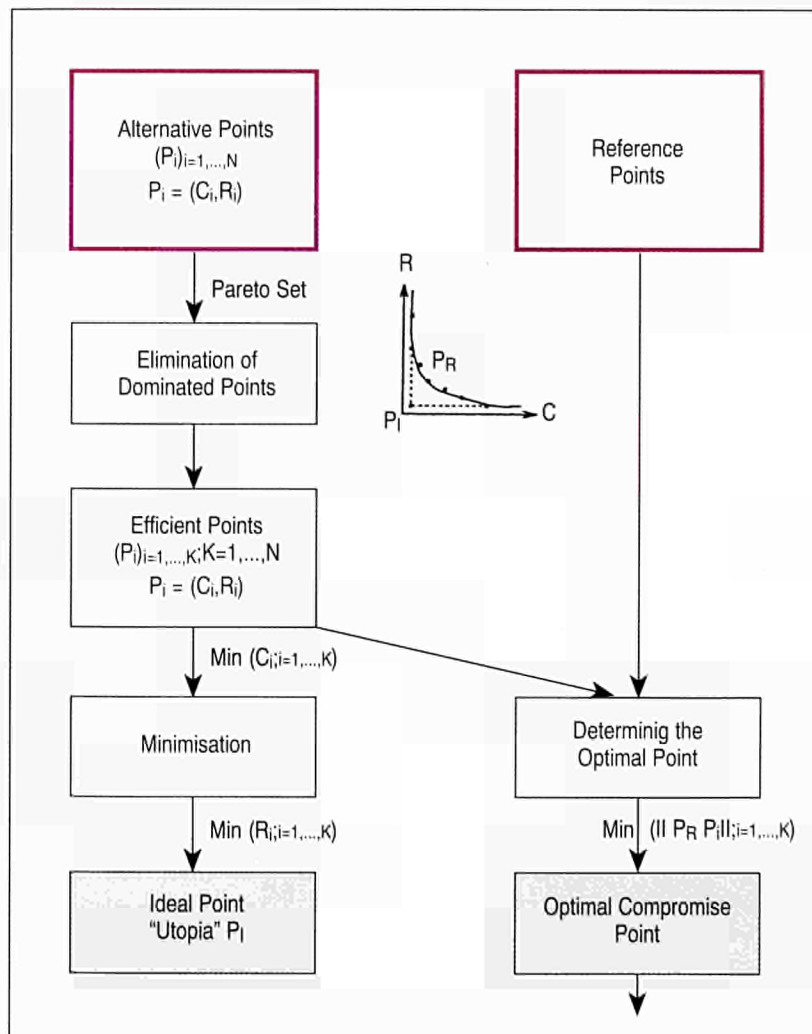
In the discrete cases, the construction of the multi criteria evaluation matrix provides a useful view of the decision space. Since it is not sufficient to give conclusive indications directly to the decision maker, procedures for comparing criteria and analysing the decision makers preferences, are needed. Pairwise comparison among all elements of the whole choice set has been used to derive the ratio of the alternatives set by the outranking relation. The outranking relation was been proposed by J. Condorcet in 1792 for the election process in a democratic organisation. It allows the majority and the minority to be considered, and the robustness of the outranking comparison can be measured by using concordance and disconcordance indices. The two main advantages of this approach are reducing problem complexity, and no assumptions are made regarding the utility function.

Fig.2.9: The Reference Point Approach.

Applications

Specific DSS developed in 1991

The main applications in 1991 have been a decision support system for the management of the Master Plan of the Po river and a DSS for the management of industrial wastes (contracts from the Italian Ministry of Environment).

References

/1/ ARGENTESI, F., PARUCCINI, M. - "Sistemi cognitivi per lo studio dei problemi ambientali" Atti della Società Italiana di Ecologia - n. 10, pagg. 59/72

/2/ PARUCCINI, M. - "Dalla analisi del rischio industriale alla gestione del territorio" La Protezione Civile - n. 4, pagg. 33/36

/3/ MUNDA, G. - "Multicriteria Evaluation Methods in Economic· Environmental Modelling", Autumn Workshop in Environmental Economics, Venice, October, 1991.

/4/ FUNTOWICZ, S., RAVETZ, J. - "Problemi Ambientali Globali e Scienza Postnormale, Proc. OIKOS 3, Lubrina, Bergamo (Italy) p103-12 3

/5/ PARUCCINI, M. - "Decision Support Systems for Environmental Management" EUR 14087

/6/ ZENIE', A., PARUCCINI, M., MUNDA, G., HAASTRUP, P. "Decision methods for environmental management", Commission of the European Communities - Euro Courses on Environmental Impact Assessment, September, Joint Research Centre, Ispra Establishment, Italy; to appear on Environmental Impact Assessment Proceedings, edited by A. Colombo, Kluwer Academic Publishers.

Integration of Geographical Information Systems into DSS for Environmental Management

Typical Environmental Management problems range from those of global scale (climate change, ozone depletion), through international scale (atmospheric transportation of radiation and pollutants), to regional and local scales (river pollution, siting of potentially hazardous facilities). What they have in common is that they are all concerned with spatially distributed phenomena. This means that the information relating to the phenomena can be spatially referenced and an appropriately chosen Geographical Information System (GIS) is the natural means to support and analyse such information.

GIS can be seen as providing three essential types of facility; data base, graphical display, and spatial analysis. The first two, data base and linked graphica display, can on their own provide a powerful instrument for Decision Support in some contexts, such as utility management. The third facility, spatial analysis, provides a way of enriching the information available to the decision makers by generating new parameters from the spatially referenced data. In Environmental Management such parameters are typical indicators of the environmental impact of proposed developments, the number of people or other living species exposed to risk etc. In some cases it may be necessary to link the spatial analysis to other simulation models in order to arrive at the required parameters on which to base a decision. One of the interesting challenges posed by currently available GIS technology is to devise ways of using the available spatial analysis functions to generate parameters which are of most relevance to the required decisions about the environment.

Two Geographical Information Systems have been installed, one for specific application to contract research, and the other for general use in data preparation and investigation of its possible use in configuration for Decision Support Systems.

Application of GEOSCOPE GIS

The GEOSCOPE GIS was chosen for use in the development of a Decision Support System for toxic waste management in Lombardy region because of several characteristics which were found to be particularly appropriate for this work:

- it operates on Personal Computers within the Windows 3.0 environment, - data and graphics can be exchanged with other applications running under Windows 3.0,

- it uses a quadtree data structure for storing raster maps which permits fast redrawing of maps with many polygons (typically several thousand in this case), suitable for interactive use,

- the possibility to exchange alphanumeric data with the spreadsheet programme EXCEL was found to be a very powerful tool for data preparation and analysis.

The system was installed on a 25MHz personal computer and geographical data on several themes for the Lombardy region (boundaries of communes, land use, networks of roads and waterways) were converted into the required quadtree format. Experience was gained in using the spatial analysis functions, such as merging, intersection and reclassifying to create new derived maps for the project. (See example in *Fig. 2.10.* Classified Map prepared

using GEOSCOPE). At the same time a contract was made with the software authors to implement several enhancements to the software which were required for this particular work.

Application of Intergraph Microstation

Intergraph Microstation is the "core" of Intergraphs GIS products. It provides powerful facilities for entry, manipulation and display of two and three dimensional graphical data. Graphical elements can also be linked to attributes which can be memorised either within the design file or in a separate data base - a fundamental facility for the creation of a GIS.

This product has been applied to the creation of a prototype three dimensional model of the area surrounding Como, in northern Italy, as a pre-study for a project on the reduction of atmospheric pollution.

The three dimensional model created includes a digital terrain model of part of Lake Como and the surrounding mountains, with superimposed road and river networks. It has been verified that the graphical elements can be linked to attribute data, and therefore that in principle with this product, roads can be represented as line sources of pollution (characterised by their emissions per unit length), while urban areas can be represented as polygonal sources (characterised by their emissions per unit area). See *Fig. 2.11* 3D Model of the Como Area.
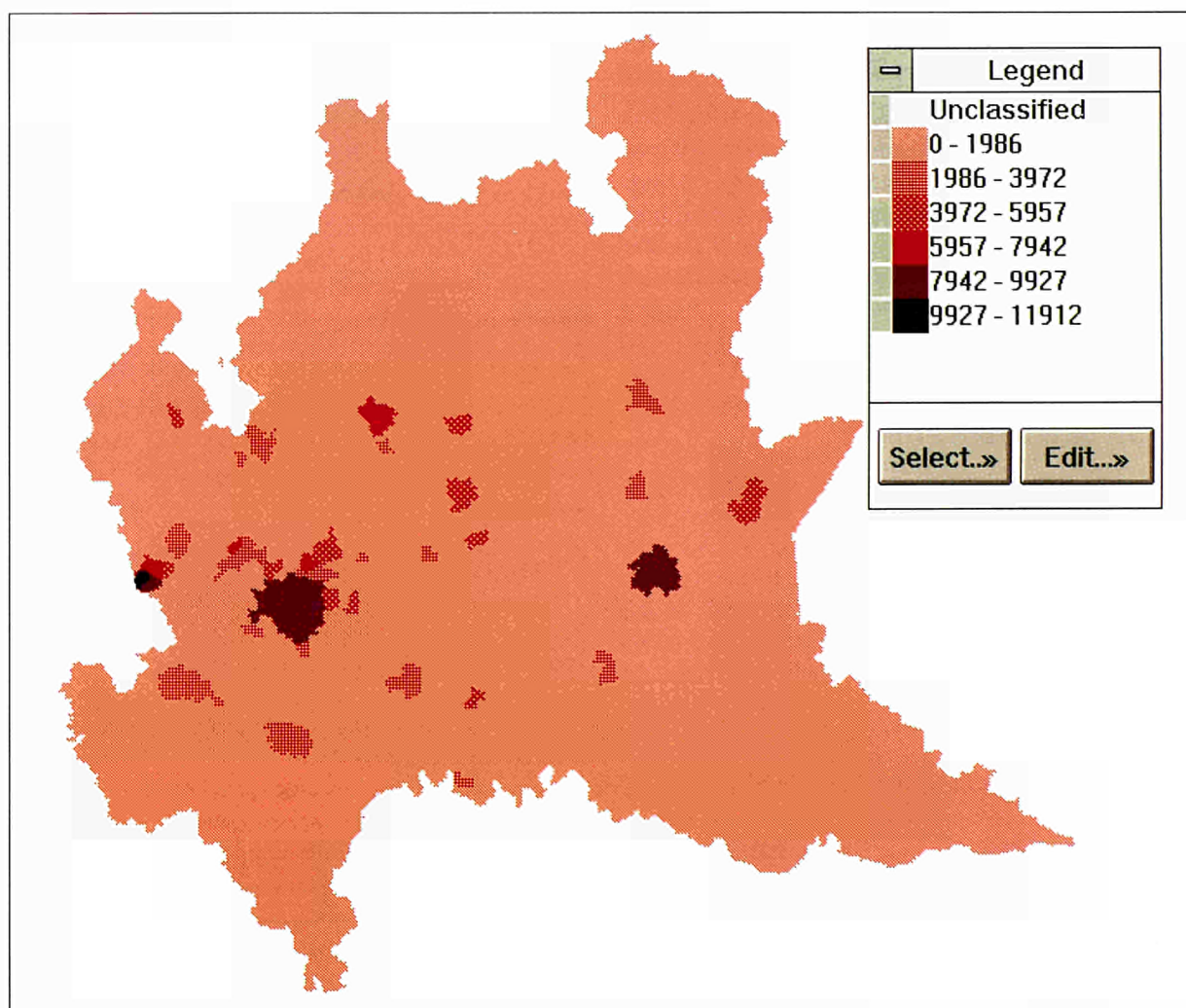

Legend

Unclassified
0 - 1986
1986 - 3972
3972 - 5957
5957 - 7942
7942 - 9927
9927 - 11912

Select..» Edit...»

Fig. 2.10: Classified Map prepared using Geoscope Application of Intergraph Microstation.
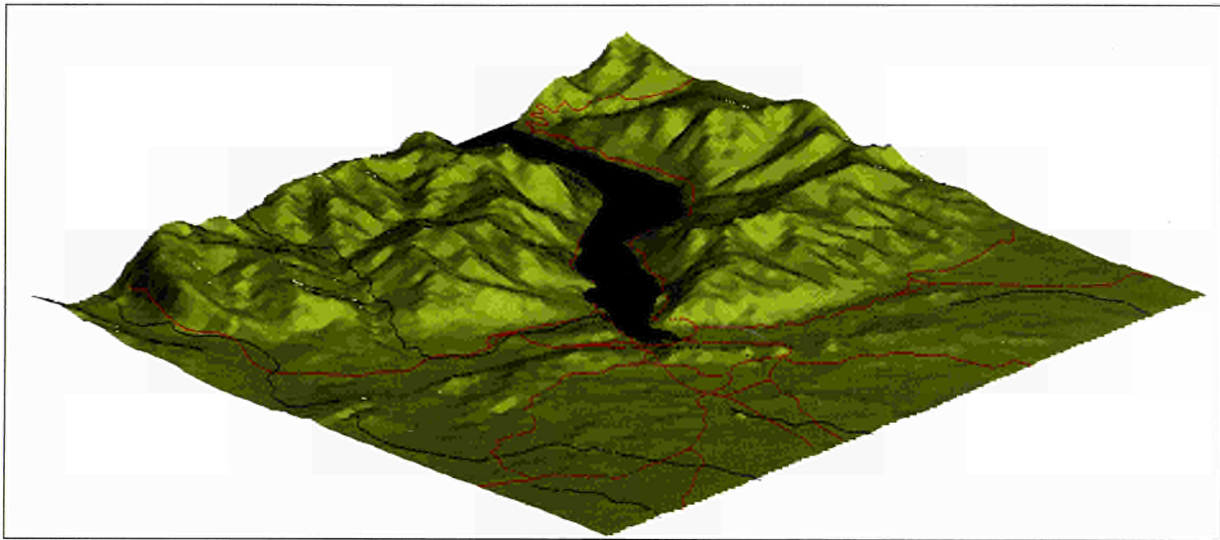
Fig. 2.11: Three Dimensional Model of the Como Area.

Linking GIS to Multicriteria Decisions Aids

It has already been demonstrated that GIS can support the required spatially referenced data and provide further insights into decision problems through spatial analysis, but there remains the problem of arriving at the final decision, in the face of multiple and conflicting criteria. This problem seems destined to become more severe as the quantity of information supported, and the number of criteria which can and should be considered, increases. This is therefore where linking Multicriteria Decision Aids (MCDA) to GIS can be of great assistance.

Work has begun on the problems of integration of GIS and MCDA, by setting down the required information flows and investigating the implications for practical implementation. The techniques of object oriented programming appear to be useful in this area as they permit the modular transmission of not only data, but also instructions on how to treat the data.

Further Developments of the MAKEMAP programme

MAKEMAP is a ISEI developed programme for preparation of digitised maps for use in decision support systems and transportation modelling. It makes use of a scanned raster image of the source map, and permits on screen digitising of the required features using mouse and cursor. Point, linear and polygonal features can be digitised. Several new facilities have been added to increase the usefulness of the programme, including several editing aids (movement of vertices of arcs and polygons, changing colour attributes), and the possibility to output the results in DXF format (a format used by many commercial CAD and GIS products) permitting the results to be transferred to Microstation. A facility has also been added to output raster files suitable for conversion to the GEOSCOPE quadtree format.

This programme was used successfully in preparation of maps for both RITO and MAPO contracts research.

References

/1/ PECKHAM, R.J. - Geographical Information in the JRC - Technical Note no.1.91.88, 1991.

Transport of dangerous goods

In 1991 research was carried out, comparing the severity of accidents from transport of dangerous goods with similar accidents related to fixed installations. The comparison was made both in relation to consequences for humans (fatalities) and in relation to environmental consequences, though it is recognised that the definition of environmental consequences is not straight forward. Also in 1991 a simple consequence model based on a fatality index approach was extended to cover not only toxic gases but also flammable liquids and gases.

Accident analysis

In order to analyse transport accidents and other accidents with dangerous goods, a sample of total 2195 accidents of interest were collected, and in *Table 2.1* the distribution of these accidents on fixed installation, loading or unloading and transport is shown.

Table 2.1: Classification of 2195 Accident Cases from the Literature.

Class	Number	%	No. with fatalities	%
Fixed installations	1190	54	520	66
Loading/unloading	123	6	47	6
Transport	882	40	216	28
Total	2195	100	783	100

Fig. 2.12: FN curve for 510 accidents with fatalities.

As seen in Table 2.1 the percentage of transport accidents are different in the total accident case sample with respect to the sample consisting of accidents resulting in fatalities. This might be due to random variations in the sample, but may also be interpreted as increasing publicity when the accidents result in fatalities.

In order to compare the transport accidents with those for fixed installations accumulated frequency-fatality curves have been constructed. Curves of this type are commonly called FN curves. In *Fig. 2.12* an FN curve for 510 cases with fatalities is shown from fixed installations (370 cases), and transport (road, rail and pipeline) (140 cases). The frequency of accidents with fatalities have arbitrarily been set to one.

A Simple Consequence Model based on a Fatality Index Approach

Traditional consequence models, including release, dispersion and vulnerability calculations can be useful for estimation of the risks related to fixed installa-
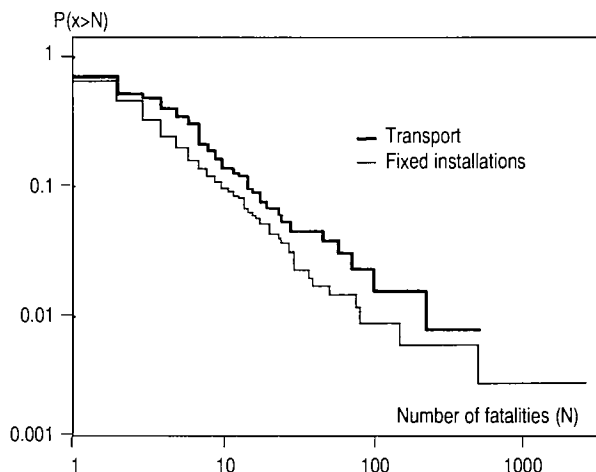
tions storing, producing or using hazardous materials, if care is taken when making the necessary assumptions, but large uncertainties are found in the results.

In 1991 a model for estimation of human consequences of a transport accident involving hazardous goods was developed, which avoids some of these uncertainties, and is believed to be more transparent than traditional consequence models, the fatality index approach.

The fatality index is defined by the equation:

$$N = \beta \times W^r = W \times [\beta \times W^{r-1}]$$

EQUATION where N is the number of fatalities and W is the amount released

The parameters were estimated in 1991 for the toxic gases chlorine and ammonia, and for flammable hydrocarbons, class 2.3 (LPG etc.), 3.3 (gasoline etc.) and 3 (diesel, fuel etc.). These parameters are summarised in *Table 2.2*.

Table 2.2: A summary of the parameters estimated for the human consequence model

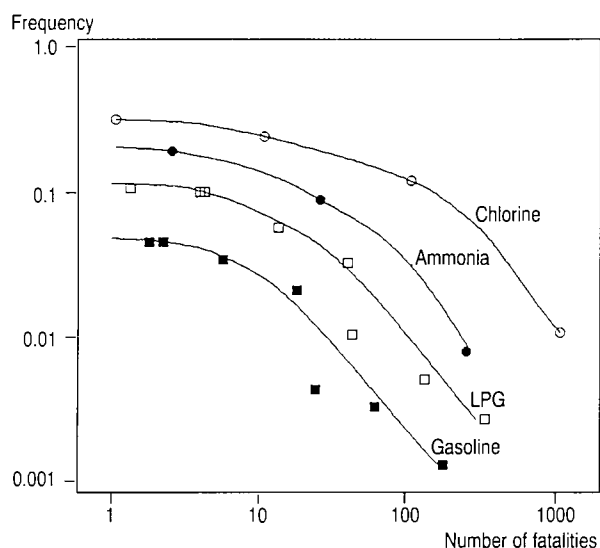|	Urban		Indust		Rural	
	P(N>=1)	Fatalities	P(N>=1)	Fatalities	P(N>=1)	Fatalities
Chlorine	0.60	5.5 x W	0.38	0.55 x W	0.16	0.055 x W
Ammonia	0.46	1.2 x W	0.24	0.12 x W	0.012	0.003 x W
Class 2.3	0.15	8.7 x W	0.12	2.9 x W	0.09	1.0 x W
Class 3.3	0.086	3.9 x W	0.064	1.3 x W	0.044	0.43 x W
Class 3	0.022	3.9 x W	0.016	1.3 x W	0.011	0.43 x W

Frequency

Fig. 2.13: The estimated f-N curves for chlorine, ammonia, LPG and gasoline, assuming a release of 20 ton.

An overview of the differences in the level of consequences for the different types of substances is better provided by a frequency-consequence curve (f-N curve). *Fig. 2.13* shows the f-N curves for chlorine, ammonia, LPG and gasoline assuming that an accident with a 20 ton release has occurred (in an area which in probabilistic terms consists of 20% urban, 30% industrial and 50% rural land use).

Comparison with fixed installations

This work compares accidents with hazardous materials related to transport and to fixed installations from a number of different points of view. The findings are summarised in *Table 2.3*.

Table 2.3: Comparing accidents from transport and fixed installation.

Type of information	Transport accidents compared to fixed installation accidents
Frequency of human accidents	Half as frequent
Human consequences	Similar, also for large accidents
Frequency of environmental accidents	One third as frequent
Consequences of environmental accidents	Similar, also for large accidents
Reliability of reporting system	Lower than for fixed installations
Uncertainty on number of fatalities	Higher than for fixed installations

As seen in the table, the results related to human accidents and environmental accidents are very similar. In both cases transport accidents lead to consequences which are just as severe as for fixed installations. However the frequency of transport accidents are "only" 30% to 50% of the fixed installation accidents. Nevertheless since the quantity of material transported seems to be increasing, this fraction may also be increasing.

Until recently the main focus in Europe was on the risks related to fixed installations, and it was in this area that the research and the political initiatives were being made. However the results presented here confirm the need for a close examination also of the transport of dangerous goods.

References

/1/ BROCKHOFF, L., STYHR PETERSEN, H.J., HAASTRUP, P.A. Consequence Model based on the Casualty Indices for Chlorine and Ammonia. J. of Haz. Mat. (1991)

/2/ HAASTRUP, P., BROCKHOFF, L. - Reliability of Accident Case Histories Concerning Hazardous Chemicals. An analysis of Uncertainty and Quality Aspects", J. of Haz. Mat. (Vol 27, no.3, August 1991)

/3/ HAASTRUP, P., BROCKHOFF, L. - "Review of Transportation Accidents of Hazardous Materials", presented at the 14th International Symposium of International Social Security Association (ISSA), Chemical Section, June 10-12, 1991, Frankfurt, Germany

Communication of Major Hazards

Communication with the public is a central issue in a number of EEC policy directives concerning the environment, industrial management and biotechnology. These directives establish the obligation to inform the public on matters relevant to their health and wellbeing. They also encourage public participation in the assessment of risks and environmental impact, as well as in the decision-making process /1/2/. The aim of the legislation is at least twofold: To guarantee the "right to know" and to provide the public with information and skills useful to avoid or prevent danger and to effectively respond to possible emergencies /3/.

In order to implement such aims, it is necessary to achieve scientific knowledge of social systems' organisation and of people's attitudes and behaviour. There is an urgent need to develop a more accurate picture of the influence of different factors in shaping perceptions of risk and of people's attitudes towards

environmental issues. Also for understanding the criteria according to which different communities and societies prepare for emergencies and respond to hazards /4/.

Research in this field has been increasingly performed in the last years, however, a number of issues have not been properly addressed or remain highly controversial. Work has been done on the relevant research findings distinguishing amongst:

- those issues which have been extensively studied, thus providing satisfactory knowledge;

- those issues which are controversial because of their qualitative or quantitative methodological difficulties, and

- those issues which have not been properly addressed yet. The focus of the work has been on methodology and attempts have been made to identify both advantages and pitfalls of different research designs and techniques. Appropriateness and correctness have been used as the main criteria to evaluate the methodology of research studies, as it is believed that this is prior to the analysis of results.

Besides relying on secondary sources, research has been conducted by contacting and interviewing public authorities, industrial managers and experts in different countries. The purpose of this activity was to know more about how public information policies are implemented and received.

The work has resulted in:

- recommendations for policy;

- recommendations for future studies in the field of risk communication;

- the design of research projects;

- the establishment of an informal network of practitioners of the field of risk communication and mass emergencies, and

- preparatory work towards guidelines for risk communication /5/6/7/.

References

/1/ DE MARCHI, B. - "Public Information about Major Accident-Hazards: Legal Requirements and Practical Implementation". Industrial Crisis Quarterly 5, pp. 239-251 (1991)

/2/ DE MARCHI, B. - "The Seveso Directive: An Italian Pilot Study in Enabling Communication". Risk Analysis 11, 2, (June 1991) pp. 20 7-215

/3/ FUNTOWICZ, S., RAVETZ, J. - A New Scientific Methodology for Global Environmental Issues, The Ecological

Economics, R. Costanza (ed), Colombia University Press, NY. (1991)

/4/ DE MARCHI, B. - "Perception of a Second-Hand Reality" (with N. Tessarin). In B. Segerstahal (Ed.) Chernobyl. A Policy Response Study. Berlin: Springer Verlag, pp. 117-132

/5/ DE MARCHI, B. - "Aspetti formotivi e comunicativi nella gestione delle emergenze". Rassegna della Protezione Civile VIII, 1, gennaio/febbraio, pp. 25-27 (1991)

/6/ DE MARCHI, B., FUNTOWICZ, S. - "Decisione e comunicazione in un contesto di incertezza scientifica" Sistemaricerca 22, aprile-giugno 1991, pp. 18-23

/7/ DE MARCHI, B. - "Effective Communication between the Scientific Community and the Media". Disasters 15, 3, (September 1991), pp. 2 37-243

STARS - Software Tools for Advanced Reliability and Safety Analysis

STARS is a project which covers the development of an integrated system of knowledge bases, knowledge based tools and other software for assisting analysts and designers in the various phases of plant safety and reliability analysis: hazard identification, event sequence analysis, systems analysis and consequence analysis.

The project aims at bringing together the domain of artificial intelligence (knowledge-based systems or "expert systems") and advanced information processing and the domain of safety and reliability analysis. It is carried out by 4 main partners (ISEI, RISOE, VTT and TECSA) and 4 affiliates (TNO, ABB, Framatome and Neste).

Particular characteristics of STARS include:

- the use of knowledge bases (KBs) which hold the general domain knowledge of safety and reliability experts, allowing this knowledge to be combined with plant specific information and knowledge as given by the plant safety analyst or the design or process engineer. These KBs include:

  • a plant/unit KB with characteristics of process plant units,

  • a substance KB containing physical characteristics and known hazards related to substances,

  • a reactions KB containing characteristics, possible deviations and related hazards of known reaction classes,

  • a component KB containing general properties for different types of components, as well as rules describing the way different types of components behave in normal and failed conditions, and

• a phenomena knowledge base: containing objects describing atomic consequences to be linked into accident scenarios the use of expert system technology for the emulation of the reasoning processes and heuristics of safety and reliability analysts allowing the construction of more detailed and reproducible models with less effort.

In particular, systems are being developed:

• an expert system for hazard identification and for construction of incident scenarios based on the analysis of the process diagram and the related knowledge about process units, substances and reactions,

• an expert system for fault tree construction based on the analysis of the P&ID and the related knowledge about component function and behaviour

• a high level of interactivity realised by flexible and advanced user interfaces based on window techniques and using CAD approaches. The X window system has been chosen for the development of the user interface.

In 1991, the STARS project entered in the implementation phase. The knowledge representation structures were developed. The KBs are organised as hierarchical structures of objects (called frames). Generic objects hold the generic knowledge, while for every element in the structural and functional decomposition of the plant a specific object is created to hold the plant specific information.

The knowledge base management system and the related user interfaces were realised. These interfaces include XFMS: a frame handling and editing system and XPLED: a graphical plant/system diagram editor that makes creation of plant specific objects transparent to the user.

The first prototypes of XQUAL, the hazard identification system and XFTCON, the fault tree construction expert system were developed. A start was made with the specification of the consequence analysis part of STARS.

References

/1/ POUCET, A., NORDVIK, J., MITCHISON, N. - Knowledge-Based Systems and Machine Learning for Enhancing Plant Safety. In: Proceedings of the 13th World Congress on Computation and Applied Mathematics, IMACS, 22-26 July 1991, Dublin (IRL) - ORA/PRO 36239

/2/ FLAMM, J., POUCET, A. (Eds.) - First ESReDA Seminar on "The Use of Expert Systems in Safety Assessment and Management" - S.P./I. 91.31

/3/ POUCET, A. - Interacting Expert Systems for Plant Safety Analysis. In: Proceedings of the Conference on Probabilistic Safety Assessment and Management (PSAM), SRA, 4-7 February 1991, Beverly Hills, CA (USA), Elsevier Publ., G. Apostolakis (Ed.) - ORA/PRO 35606

REFERENCE METHODS FOR NON-NUCLEAR ENERGIES

The contribution of the Non-Nuclear Energies Service to this line of activity was mainly in the field of photo-voltaics, with a smaller contribution from solar passive studies. The nature of the work was principally normative and prenormative, with an emphasis on the development of testing methods.

Reference Methods for Photovoltaics

Work undertaken within the Framework Programme is concentrating on pre-normative developments of test and measurement methods. A certain amount of basic research concerning the physics of Photovoltaic (PV) devices is also necessary in order to maintain the scientific standing. Research and Development on testing methodologies becomes increasingly important because industrial PV technologies proceed and require in-depth assessment of device performance and lifetime. ESTI (European Solar Test Installation) concentrates its research on projects which have a clear orientation to the users of the results, the Standards Organisations such as IEC and CENELEC and the Photovoltaic Industry.

The main activities in 1991 were in the following fields:

• basic research on physics of PV devices

• new measurements and test methods

• new specifications for norms and standards

Basic Research on Physics of PV Devices

For about four years, ESTI has maintained an active scientific collaboration with the photovoltaic research group of the university of Ferrara through which a close contact was established with the Italian PV industry. The purpose of this activity is to identify the main factors limiting the efficiency of commercial low-cost solar devices and to test the performance of cells with unusual geometry or construction properties. The collaboration allows a unique combination of the cell construction capabilities of a large Italian photovoltaic company with the performance measurement techniques of ESTI.

"Reverse" monocrystalline silicon cells showing very low series resistances from recent Italian production were studied both experimentally (determination of carrier lifetimes, carrier surface recombination and carrier diffusion length) and by numerical simulation. As these devices do not require a shallow junction the deposition of a low resistive contact on the emitter side is greatly simplified, making large fill factors easily achievable. Since the light generated carriers are created far from the junction, inverted cells show, however, low short circuit current values. Numerical simulations (2-3) have shown that these devices will become competitive only with the availability of thin (<50uM) silicon wafers. In order to improve the light collection efficiency in the long wavelength region a comparative study was made on the reflectivities of Al and Ag deposited on silicon by serigraphy and by vacuum deposition. First results however show that texturing the back surface gives overall results superior to any metallisation. This work is still in progress. A numerical programme (Pascal and C versions exist for HP9000) for the steady state solution of the carrier transport equations and of the Poisson equation which includes effects of high doping as well as generalised boundary conditions has been developed and adapted to solar cell simulation. The programme is not limited to low injection and shows good convergence properties. The model was also used to calculate the diffusion capacitance of differently doped solar cells. These calculations can explain the abnormal behaviour which high-efficiency devices exhibit when measured with flash simulators. The graph shows the increase of the capacitance as a function of applied voltage for different doping levels *(Fig. 2.14)*.

Measurements and Tests

ESTI contributed for a second time (the first time ESTI was operating agent) to the Solar Cell Calibration Round-Robin within the Technology, Growth and
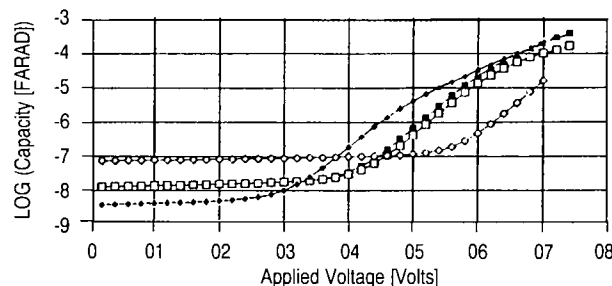

Fig. 2.14: Static Capacitance vs Applied Voltage.

Employment Group of the G7 (Summit). Focus was now the calibration of a Si-thin-film devices. The scope of the Round Robin was, to assess high-precision calibration methods and their suitability to advanced technologies. While accuracies of better than 1.5% can be achieved when applied to crystalline photovoltaic technology, thin-film devices such as amorphous silicon or multi-junction alloys need special methods for calibration. The contributing laboratories (USA, UK, Japan, Germany, Italy, Canada and ESTI) applied their most precise method to a set of 20 cell and module samples, in order to establish an accuracy value. In addition, a simplified method was tried and implemented in each laboratory in exactly the same way.

This simplified method is proposed by the IEC as a cost-effective, but still precise, calibration method. ESTI is able to calibrate with three different methods; it is the only laboratory which implemented a spectral response calibration method applicable to large modules. As result the measurement under direct sunlight (using only the fraction of light directly from the suns disk) using a cavity radiometer as reference proved to be the most precise. ESTI has used this method for several years. The simplified method was found not to meet the criteria for primary reference cell calibration. The calibration data for amorphous silicon devices showed a higher spread between the laboratories, indicating that some effort is still required to satisfy the accuracy needs of the industry. The Round-Robin of the Summit will enter into a new phase in 1992/1993.

Analysis of Solar Spectra

Sun Spectra, taken with the IRIS Spectroradiometer, were analysed with regard to the calibration precision of silicon cells. The study was necessary for assessing the measurement errors of the outdoor calibration of Primary Reference Cells. Because photo-

voltaic devices are spectrally selective, their calibration data are referred to a standardised solar spectrum. During outdoor calibration the solar spectral irradiance usually differs from this standard and thus influences the calibration results. Aim of this analysis was to find a set of parameters which characterise the actual solar spectral irradiance in terms of its deviation from the standard and its influence to calibration precision. The experiments required a sophisticated wavelength and irradiance recalibration of the instrument.

Investigations on Measurement Errors due to Speed Effects of Flash simulators have been performed. New high-efficiency devices appear on the market which exhibit anomalous behaviour when measured with flash simulators commonly in use. A test set-up allowed to measure and interpret the errors introduced by these speed-related effects. Measurements of the Current-Voltage (IV) characteristics of photovoltaic devices are conveniently performed using flash solar simulators. Present technology of these large area pulsed simulators limits the duration of the light pulse to the range 1.2 ms. Measurements performed at ESTI on certain cells and module technologies indicated that considerable errors are introduced during the relatively fast trace of the IV-curve. The objective of the work was to set up a facility to investigate these effects and to compare the time-response of advanced solar cell technologies. The underlying electronics are quite complex but provide results rapidly, so far under natural sunlight (no artificial light source at ESTI meets presently the necessary requirements). The analysis of the data shows that errors of 15% can be expected in the determination of the fill factor when simulator light pulses of 1.5 ms duration are used to measure the electrical performance of back-surface field solar cells. Thin-film technologies are less susceptible to this effect. A capacitance model was applied to the experimental data in order to explain the effects. One conclusion is that the back-surface doping of high-efficiency devices creates a very large diffusion capacitance, adjustable by bias-voltage. It is not yet sure whether an eventual spinoff could be a new voltage-controlled semiconductor capacitor. As these results have a strong impact on modern cell technology, two PV manufacturers are already asking for such tests to be executed as third-party work. ESTEC also has shown strong interest for applying this method to their space-array measurements, and thus in 1992 a collaboration on the subject will start. As a further result of the study, ESTI defined requirements for a flash simulator and finally purchased a system with longer flash duration.

Qualification

A new test was developed to measure under defined and stable conditions the light soaking effect of amorphous modules; it was proposed successfully to the IEC as international standard. In 1991, ESTI was already selling this test to two manufacturers. Photovoltaic modules made of thin-film amorphous silicon exhibit an initial power reduction when deployed in the field. The process is reversible by annealing, that is, by heating the device to about 60 deg.C. for a certain period. The qualification test schedule needs to imitate this effect as one cannot assume that a manufacturer sends modules for qualification tests which are already stabilised. As test facility a large area array solar simulator was modified (the simulator previously served for testing thermal collectors) which allows a 1000 h exposure to light similar to sunlight. The main feature of the system is that the temperature of the modules to be degraded can be controlled between 0 and 75 deg. C. As the degradation process competes with the annealing, one expects a reduction in measurement time when the modules are climatised at low temperature. This light-soaking test is an essential part of ESTI's new Specification 701.

While in the past this type of measurement was performed within Europe only by ESTI there is now a growing interest from other groups to apply such techniques to the analysis of their installations. In particular, the importance of the methods developed by ESTI to derive the data referring to Standard Test Conditions (inplane irradiance of 1000 W/m² with a spectrum corresponding to "Air Mass" 1.5 global, module temperature of 25O) from the actual measurements became quite obvious. They became part of proposed standards of the International Electrotechnical Commission (IEC). A summary of the latest results and a detailed description of the techniques were presented at the 10th EC Photovoltaic Solar Energy Conference in Lisbon, April 1991.

Also, in order to determine more precisely the limits of validity and the precision of this extrapolation procedure a joint study involving guests from the Solar Energy Research Institute (SERI) (Colorado - USA) and the Alfa Real AG (Zurich - Switzerland) was carried out in the ESTI laboratory. The results were presented at the IEEE PV Specialists Conference in Las Vegas in October 1991.

Specifications (Norms and Standards)

Specification 503. Since 1983 ESTI has been contributing actively to the Standards work of the International Technical Commission (IEC), Technical Committee 82. ESTI's previous module qualification Specs 501 and 502 were the basis of the new IEC draft proposals to be issued by the end of 1992. The new Specification 503 is a description of the implementation of the future IEC test sequence at ESTI and serves as an intermediate de-facto standard. The success is overwhelming, both in the number of distributed copies and in request for tests. The experience with this qualification schedule is good, both in terms of cost-effectiveness and failure simulation. The IEC and the industry indicated their satisfaction to have an experimentally proven standard prior to publication of the official IEC document.

Specification 701. As new thin-film technologies evolve, measurement and test procedures must be refined. ESTI invited Industry and Laboratories to form a "Thin Film Qualification Task Force" for the definition of a proposal and a work-plan to solve the specific issues. The intermediate result is the Specification 701, which implements very innovative test procedures to handle problems of these advanced technologies such as light-degradation and insulation resistance under wet conditions. USA, Japan and France are also working on thin-film module qualification standards but consider the Spec. 701 as the most logical and rational one. Japan and Germany adopted it as draft national standard. Specification 701 in its version 2.1 is a CENELEC working document.

Reference Methods for Solar Passive Energy

The Non-Nuclear Energies Service contributes to DG XII's PASSYS project, with work concentrated on the development of reliable test procedures for building components and on the development of identification tools for thermal parameter assessment. Two identification methods are currently being used by members of the PASSYS project: one is based on a lumped parameter model and the other on a continuous time model. Two workshops have been organised on this subject, at Ispra, over the past two years.

Contributions to the final products of the PASSYS project are an investigation of the seasonal influence of the solar aperture parameter and the technical inspection, by ISEI staff, of the 12 European outdoor solar passive test sites.

In line with ISEI's new orientation towards the study of energy-environment interactions, the possibility is being explored of using the test-cell facilities for the investigation of problems related to indoor-air quality.

RELIABILITY OF STRUCTURES

Acquisition, Storing, and Display of Data from Reaction Wall Experiment

Data acquisition

A modular acquisition system for measurement signals has been designed and a prototype with one channel realised in laboratory. The system is based on several PC interconnected on a network. The developed interface module to the sensors provides an digital programmable offset of the measurement bridge from the computer.

Data storing

The general software package EDF for storing and handling experiment data has been developed and installed on UNIX workstations (HP and SUN) /1/. This software has been adopted by the IST for several experiments. The database has been incorporated with the NFS (Network File System) of UNIX to allow transparent network access. The VMS installation has been maintained in parallel. The software release mechanism has been put under control of the UNIX tools SCCS and make. These together with specially developed script files ensure unique source files for all versions.

Software has been implemented which allows to transfer data from the VAX/VMS database to UNIX database. In this way all experimental data stored on the VMS implementation is now accessible from UNIX workstations.

Data visualisation

A new data visualisation system for EDF data has been developed. This is based on the PV-wave software package. It provides UNIX workstations with powerful tools to display results in 2 and 3 dimensions.

The new applications (SPLASH and D3PLOT) have been written in the PV-wave command language /2/. The user interface is 100% mouse based, allowing multi-window displays of 2-D and 3-D graphs with zoom and rotation facilities.

The interface of PV-wave to the EDF database has been achieved by writing a C background process which communicates with PV-wave via remote procedure calls. This performs the interrogation and data retrieval of the database, and allows to generate dynamically mouse driven menus.

Some examples workstation displays from SPLASH and D3PLOT are shown in *Fig. 2.15* and *2.16*.
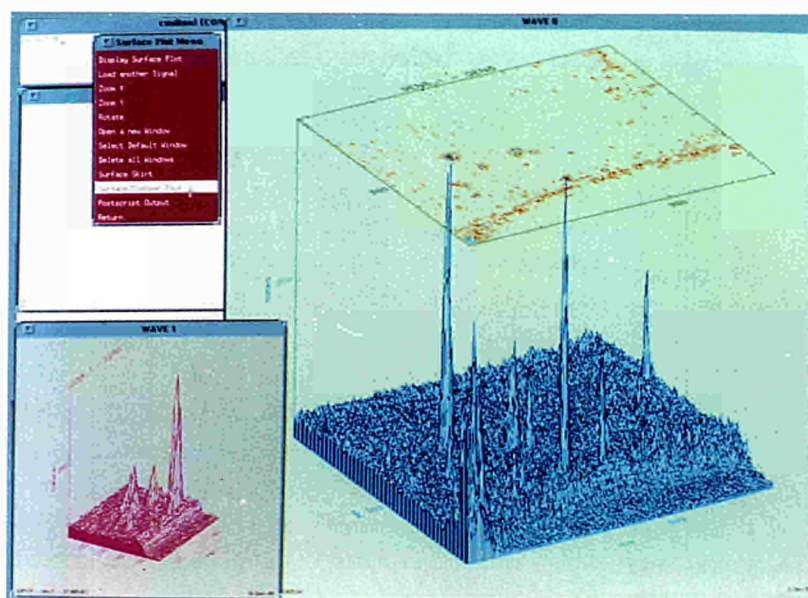
Fig. 2.15: Example of D3PLOT display.
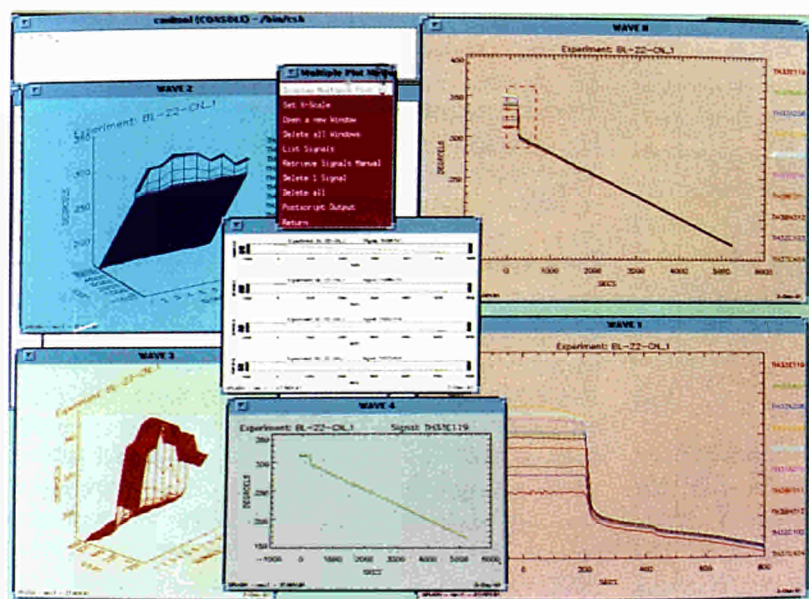
Fig. 2.16: Example of SPLASH displays.

References

/1/ BEST, C.H. - "Experiment data files, a general system for storing data from experiments, UNIX version - Technical Note N. I.90.96, October 1990.

/2/ BEST, C.H., ROEBBELEN, D. - "SPLASH - A PV-wave application interfaced directly to the EDF database" - Technical Note in print.

Reliability Modelling of Structures

The objective of this work is the development and validation of methods and procedures for reliability assessment and lifetime prediction by knowledge engineering and diagnostic techniques. The aim is pursued combining properly designed experimental tests on scaled components of complex geometry, development of analytical tools and development of non-standard non-destructive-evaluation (NDE) techniques.

Tests on 1:5 scaled vessels

The destructive examination of vessel A-R2 (whose fatigue test was ended in 1990 after the appearance of a leak in the lower plenum at cycle 900000) has been continued /1/. Two types of crack were present:

- the crack nucleated and propagated in the attachment weld of the inlet pipe in the lower dome and leading to the mentioned leak;
- fabrication cracks, situated in the different welds, and propagated during the fatigue treatment.

The results of the examination of the first crack were analysed together with the ones already obtained with a crack nucleated and propagated in the corner of one of the two nozzles (Phase 1 of Fatigue Testing on vessel A-R2). The study was carried out in collaboration with CISE-Milano and was partially supported by EPRI-USA. The interest of these two cracks comes from the fact that:

- they are service induced and service propagated cracks;
- they are located in regions which are the most critical also in real plants: penetrations in upper or lower plenum; nozzle corners;
- the geometry of the experimental set-up was as complex as the real one, and similarly complex were the stresses;
- the complete record of the load history was available, including periodical beach marking loadings.

This makes the cracks particularly apt to contribute to clarify the Environmentally Assisted Cracking (EAC) which is one of the main causes of failure for plant components.

The predicted crack growth rates have been compared with the actual crack growth history, experimentally determined via the examination of the fracture surfaces by optical and scanning electron microscope. The results show that the Stress Corrosion Cracking (SCC) component produces a high crack growth rate; nevertheless, it is never dominant all over the crack front but affects small regions of it so that the environmental effect on the mean crack growth rate is limited. The observed crack growth rate is higher than the one predicted without accounting for SCC, but lower than the maximum crack growth rate expected by the Environmentally Assisted Cracking (EAC) models. This confirms the presence of some time dependent EAC, which must be accounted for when lifetime predictions are made,

although further work seems necessary before EAC models can be introduced in lifetime prediction codes with a high confidence level. The problem is very important for cracked components exposed to aggressive environment and, particularly, when life extension assessments are to be made. Pressure vessels of nuclear reactors constitute typical relevant cases, both because of the present trend towards life extension and because in the pressure vessel steel the stress corrosion component of crack growth rate is very high /2 /3/4/.

Pressurised Thermal Shocks

Phase 1 of experimentation has been completed: 1500 thermal transients have been performed; two periodic inspections were carried out (after 1000 and 1500 transients respectively); relevant temperature and pressure data has been analysed for crack propagation prediction. No propagation has been either detected or predicted for the nozzle corner crack. Phase 2, in which higher values are planned for the stress intensity factor at crack contour, is being started in January 1992. The software and hardware facilities of the experimental test rig have been modified so that a continuous unsupervised operation is possible. In order to perform periodic on-line measurements on the crack dimension, a commercial system based on potential drop method has been modified and a system of permanent probes installed on the nozzle corner and calibrated /5/.

The basic structure has been designed of the knowledge based system BOSS (Backtracking and Overviewing for Structural Safety) conceived as an example of high level controller of a plant: management of the test rig operation, data analysis, safety and reliability evaluation. A block diagram of the BOSS functionality is shown in *Fig. 2.17.*

Development of the Knowledge Based System RAMINO (Reliability Assessment for Maintenance and Inspection Optimisation).

The related project (BRITE 2124) ended. A prototype of the knowledge based system (KBS) RAMINO has been implemented. It contains the basic knowledge to perform the reliability assessment of a structure starting from data on material, loading conditions and defects. A "default base" of data and knowledge has also been implemented to allow a "conservative" assessment when some information on the very structure is not available /6/.
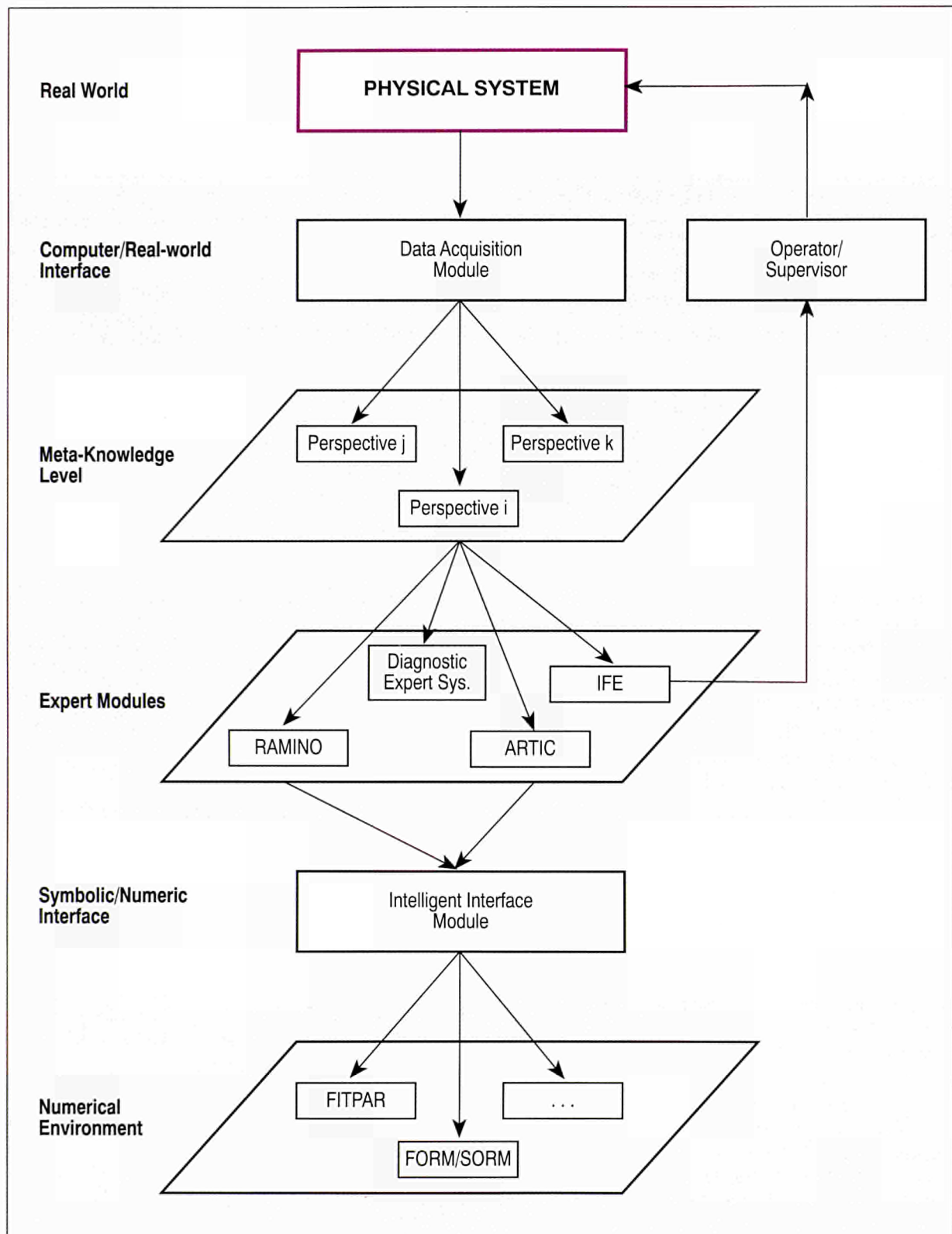
Fig. 2.17: Block Diagram of the BOSS functionality.

Non Destructive Evaluation Techniques

The laser holographic interferometry technique has been successfully applied on graphite-epoxy composites for the detection of impact induced damage and subsurface fabrication imperfections, and on aircraft panels for the identification of the vibration modes /7/.

A Bench Mark Exercise on the application of Acoustic Emission as a damage monitoring technique on fibre reinforced, graphite-epoxy composites has been started in the context of the EAMA (Acoustic Emission on Aeronautic Materials and Structures) group.

Two new devices (high sensitivity interferometric sensors for the detection of extremely low values of: temperature gradients, light intensity, pressure gradients, micro-vibrations; fully-optical modulator acting like a non-linear photo-refractive crystal have been realised during experimentation partly connected with exploratory research activity on Light Squeezing. Application for patents has been made.

References

/1/ LUCIA, A.C., PAPADOPOULOS, I.V. - "Ispra scaled model of pressure vessel" - Technical Note ISEI/SER 2086/91

/2/ GABETTA, G., RINALDI, C., LUCIA, A.C. - "A comparison of two Environmentally Assisted Cracking models for crack growth rate prediction in a scaled pressure vessel", 7th International Conference on Pressure Vessel Technology

/3/ SOLOMOS, G.P., MOUSSAS, V.C. - "A time series approach to fatigue crack propagation" Structural Safety, 9, 1991, pp. 221-226

/4/ DUFRESNE, J., LUCIA, A.C. - "Assessment of the residual lifetime of reactor pressure vessels" SMiRT 11, Tokyo, August 1991

/5/ LUCIA, A.C., PAPADOPOULOS, I.V., SCHWARZ, U. - "Pressurised thermal shock experiment of Ispra scaled models of pressure vessel" - Technical Note ISEI/SER 2148/91

/6/ A.C. Lucia; G. Volta "A knowledge based system for structural reliability assessment" SMiRT 11, Tokyo, August 1991.

/7/ SOLOMOS, G.P., ZANETTA, P., FACCHINI, M. - "Vibration studies using laser holographic interferometry" - Technical Note I.91.148 ISEI/SER 2172/91

Advanced Material Reliability

Objective: Development and application of diagnostic tools and non-intrusive techniques for material and component damage assessment.

Good results have been obtained in the detection of delamination and of impact induced damage on graphite-epoxy composite plates by means of real time laser holographic interferometry /1/. The importance of the results obtained comes from the fact that the interferometry has been applied:

- in real time - using a simple thermal loading (2°C temperature increase obtained by a lamp);
- the inspection was made on the surface opposite to the impacted one and the damage was barely visible even on the impacted surface

The work has been carried out in collaboration with aircraft manufacturers and has led to the set-up of a third party work contract.

Improvements have been achieved in the use of adiabatic thermal emission measurement for material damage assessment.

Analysis of the thermal response to deformation of composite material (fibre reinforced, graphite-epoxy) allows for a novel definition of yielding based on the thermoelasto-plastic limit. It was also found that damage sites, such as those due to matrix cracks or delaminations, could be identified by their thermal response to deformation /2/. Further tests for confirmation of the results are necessary.

References

/1/ SOLOMOS, G., LUCIA, A.C. - "Delamination detection via holographic interferometry". Workshop on Composite Materials, Trieste, nov. 1991

/2/ LUCIA, A.C., MELVIN, A.D. - "The thermal response to deformation of laminates" Workshop on Composite Materials, Trieste, Nov. 1991

FUSION TECHNOLOGY AND SAFETY

Next Step Activities

Feasibility Study on Blanket Segment Attachment Locking System

The ISEI contribution to the attachment locking (AL) system for the first wall/blanket segments (FWBS) inside the inboard region of the vacuum vessel was focussed onto the design solution for the Twin-Belt (TB) concept. Among the retained four systems for the AL, the TB Concept follows the approach of using an intermediate toroidal, structurally continuous, supporting system.

The dedicated NET Task has been carried on by the TESLA Group in agreement with the functional requirements defined by the NET Team. The Requirement Definition Document (RDD) and various technical reports on the preliminary studies, the critical assessment and the key design choice have been published. After a design optimisation process, detailed drawings on the final solution have been prepared. Structural verifications based on detailed computer simulations by means of dynamic analyses have been also performed.

The key design choices concern an angle of inclination (about 45%) for the superior/inferior grooves and an additional double bolting system located in correspondence of the upper belt, in the region of the plasma chamber behind the upper diverter plate. It has been checked how the intermediate structure of belts participate correctly to the supporting function of the transient electromagnetic (EM) loads induced during plasma disruption events and of the gravity loads. The major advantage gained is that the adjacent segments remain independent one from the other with a big advantage for Remote Handling (RH) operations and for differential thermal effect accommodations. The present design concept avoids the possible difficulties of the other systems in compensating differential loads in case of asymmetric load distribution and of FWBS anarchical behaviour. In addition, back-up remote operations are included by disassembly of the twin locking system, which is inserted as two independent "cassettes" inside the FWBS.

Next milestones consist in the specifications for Technological R&D. The final report summarising the previous steps will be presented in spring 1992.

Electromechanical Effects of Plasma Disruption Events

With the contribution of numerical modelling and computer simulations, the TESLA Laboratory has carried on the investigations onto the real impact of the accidental events of plasma disruption on the mechanical design of the internal reactor components.

Computational strategies in magneto-structural analysis have been extended in order to investigate the real effect of the magnetic damping, encountered when coupling effects between eddy currents and deflection are taken into account. Three different numerical approaches modelling the mutual field-structure interactions during transient electromagnetic events have been developed and applied.

In the context of the TEAM (Testing Electromagnetic Analysis Methods) Workshops, the TEAM Problem 12, a coupled electromagnetic-mechanical benchmark case with a plate in bending, has been successfully solved /1/. Using the Trifou code, the new TEAM Problem 16, a coupled magneto-structural problem for a plate in torsion is now under examination.

In addition, investigations on Eddy Current Heat Deposition during Plasma Disruptions in the FWBS have been performed. Results in term of Joule losses have been obtained. This activity is complementary to Exploratory Research Studies performed at JRC Petten on thermal heat deposition in FWBS components in the same context.

Finally, the recent issue of Halo Currents as initiator of accident sequence has been examined. Preliminary plasma disruption modelling techniques involving the effects of plasma vertical instability and shape change through a magnetic field are under development.

Research activity is concentrated on the modelling of microscopic processes combined with experimental results which are available from JET.

Studies for Remote Handling of Blanket Handling Device (BHD)

The activity has progressed along two lines, namely computer simulation and experimental validation on a 1/3 scale mockup of one NET/ITER sector, inside the TELEMAC Laboratory. In parallel, a Safety and Reliability Analysis of BHD has been undertaken.

Computer Simulation

The purpose of this activity is to develop an integrated system supporting the design of remote handling systems for the assembly and maintenance of a nuclear fusion plant. The support provided by the system is based on simulation techniques: kinematic, dynamic and visual simulation. The system accepts design model of remote handling equipments and environment created using the MEDUSA CAD system, and supports the assembly of the robot. In the future, planning of task and subtasks will be possible as well as collision detection and collision avoidance.

The necessary integration of CAD subsystems with visual simulation modules has been completed with the creation of the MEDVIS module which translates models from MEDUSA to the internal representation.

An Assembly module has been implemented to allow the creation of hierarchical data structure of the robot system. A Visual Simulation module, based on the direct kinematic approach was also implemented.

The Inverse Kinematic module provides a numerical system necessary for the visual simulation and the interactive planning of the task of the robot arm. The user is able to control interactively the position and orientation of a reference frame attached to the end effecter. Three different algorithms have been implemented to solve the inverse kinematic problem, depending on the constraints and objective of one task.

The User interface module connects and integrates all the modules of the system in a consistent environment, were the user will be allowed to execute the necessary operations for designing, planning and verifying via visual simulation a robotic arm. For this purpose, the user interface supports first of all the assembly phase of the robotic arm by connecting together the various links composing the complete structure. The problem of assembling robotic arm and environment consists of the extraction from the CAD system data base: three kinds of joints are being considered including rigid joint, rotational joint and prismatic joint.

A study on the static and dynamic behaviour of the inboard blanket has provided important information on the blanket behaviour during removal and insertion sequence.

A detailed analysis of the state of the art in collision detection and avoidance was also performed. Solution to this problem is a necessary step toward a system which could simulate robot tasks and solve path planning in an automatic way /2/.

Experimental Validation

The purpose of this activity is to validate the results of the simulation activity on a 1/3 scale mockup. The machine used, ROBERTINO, see *Fig. 2.18*, is a gantry robot whose purpose is to extract and replace the blanket segments of a fusion reactor. In all there are four axes: x, y, z and a rotating head. For each axis there is a corresponding joystick for manual control. In addition, there is an automatic mode which can perform movements either by using parameters sent
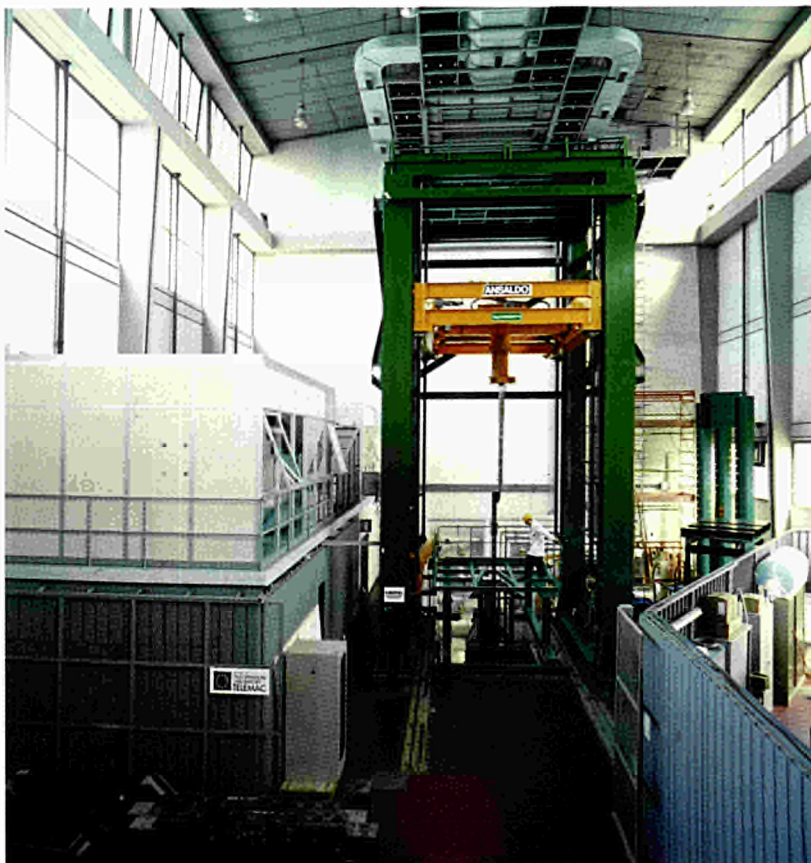

Fig.2.18: ROBERTINO facility.

from a PC, or by learning from the joystick and repeating the "taught" profile.

The mechanical data are the following:

- axis travel lengths: 3000 mm(x), 2200 mm(y), 6500 mm(z);
- rotation axis travel: unlimited;
- payload: 5000 kg;
- maximum error in the all workspace: 1 mm
- repeatability: 0.1 mm

On the computer simulator installed on a CDC Cyber workstation, a file is produced following the step size required by the user. The workstation is located in in a different building and communication is send to the control room via LAN. Translated into the appropriate format the comands are then sent by a serial link to the control cabinet of the robot.

The mockups of the vessel and of the in-vessel components were designed in the most flexible way, in order to comply with possible changes in the design of the reactor. The vessel sector mockup is installed on a trolley that can be moved under the gantry robot or taken away from it for maintenance and improvement. An upper trolley, with a blanket storage rack, is installed at the ground level.

A first Safety and Reliability Analysis of BHD has been carried out and presented to the NET Team. It was the opportunity to present the concept of the Remote Handling Workstation.

Blanket Studies

The modular blanket design, which was studied in the past for the different lay-outs of NET and DEMO-NET I, has been now integrated in the new geometry of DEMONET II (Step 4). In particular, the new specifications of DEMONET II allowed to achieve a better blanket coverage due to two essential modifications:

- the extension of the breeding blanket behind the upper and lower diverter plates on the inboard side and
- the realisation of a better packing ratio of the blanket modules inside the segment box by changing the curvature of the different units on the outboard side.

New 3D calculations of the tritium breeding rate (TBR) indicate that self sufficiency in tritium supply can

be achieved in this lay-out without the implementation of an additional Beryllium neutron multiplier.

In a meeting in Saclay with the CEA and ENEA representatives the main results of the ISEI work on the Pb-17Li/water cooled blanket design have been reviewed and the means to transfer the know-how acquired in these years to the other partners have been agreed. By this way the ISEI contribution to the European Blanket Conceptual Design Studies is now ended.

Safety Analysis

During the normal operation of ITER, structural materials are subjected to a neutron flux and are thus activated. In post accidental conditions, the decay heat generation of the activated structural materials can be very dangerous, especially in conditions of prolonged absence of cooling. (Total Loss of Cooling Accident (SEA 3.8)).

The consequences of a total loss of the active cooling of the whole device, possibly after a loss of the off site electrical power, have been analysed. The most pessimistic conditions are assumed, like the absence of any cooling mechanism other than conduction and radiation. At the outer part of the cryostat, natural convection boundary conditions were assumed.

The post accident temperature transient of the outboard components, including the magnets and the cryostat, has been modelled with the help of P-Thermal package, based on the afterheat generation that was predicted with the ANITA code.

The calculations have been repeated for a variety of initial and boundary conditions and for three alternative steels. A mesh sensitivity analysis, which confirmed the good accuracy of the code, was also performed. The cause of the discrepancy between a simple and a more detailed model was found to be a programming error on the simplified model geometry.

Results concerning the ITER outboard transient after a Total LOCA were reported. It was confirmed that, following the results stated above, no meltdown of any major component is to be expected and that the temperature peaks at about 900 °C six to eight weeks after the accident.

A more accurate 2.5 dimensional model (i.e. midplane bi-dimensional with conductive links between

major inboard and outboard components to simulate the heat flux in the poloidal direction) of a complete 11.25 degrees sector of ITER, including the inboard part of the device, is in preparation. Preliminary results seem to confirm the results obtained up till now.

References

/1/ RICHARD, H., PAPADOPOULOS, S., CRUTZEN, Y.R. - TEAM Proc. "Problem 12: Evaluation of the Magnetic Dumping" International 91 TEAM Workshop - Sorrento (Italy)

/2/ BECQUET, M., FARFALETTI CASALI, F. - Remote Maintenance and Assembly of Fusion Reactors. In: Proceedings of the 11th SMiRT Conference, AISMiRT, JAES, 18-23 August 1991, Tokyo (Japan) - ORA/PRO 36244

Reliability Assessment of JET Robotics Transporters

The topics of the analyses are the main crane (150 T) communication system and the articulated boom.

Main Crane (150 T) Communication System

The different points of this are:

- Analysis of line noise effects and line quality.
- Failure mode analysis for communication, software, hardware and operator.
- Probability of loss and spurious actuation of terminal relays.
- Probability of loss of load indication.
- Alternative and back-up solution to the multiplexer.

The tests that were used before to determine the line quality were based on the detection of wrong bytes transmitted continuously during a long period (10 millions 40 byte pockets) but on a relatively low rate: 1600 bit/sec.

No errors were detected during these tests but no information about the margin with respect to the maximum rate are available. The line quality was tested with a square wave generator and an oscilloscope to determine that margin. The result of this test is that the maximal speed is 10 K bit/sec with the present communication line.

Regarding the probability of loss and spurious actuation considerations of the reliability aspect of this problem has started. A first analysis was done on the relays installed on the interface board inside the multiplexer system. Taking average values, the failure

rate is in the order of 160 10⁶ failure/hour. Failure distribution is the following: 80% open circuit, 20% short circuit. This preliminary analysis will be refined and extended to the terminal relays.

Analysis of the Articulated Boom

The different aspects of this activity are:

- Failure mode analysis (FMECA) and effects in free navigation and with loads (load conditions in various operational scenarios).

Retrieval methods.

- Reliability of control system and components.
- Advice on safety criteria for communication software, hardware and operator fault avoidance.

At this stage the FMECA analysis is completed as well as the logical model of failure modes (fault tree). This model has already provided inputs in the definition of software routines for on-line detection of failed components and/or subsystems. Some of those routines are already designed /1/.

An impact analysis of the boom against one of its mechanical stops was performed using the ADAMS code.

The specifications of the new boom controller have been discussed between JET and ISEI and an agreement was reached to provide adequate support to JET in testing that software.

References

/1/ BECQUET, M. - Reliability Improvement of Robotics Systems. Analysis, Design and Real Time Supervision. In: Proceedings of the Workshop on Safety Implications of Plant Automation and Robotics. IAEA. 11-15 November 1991, Wien (A)

Low Activation Materials (LAM)

New criteria for definition of the so-called Low Activation Materials have been proposed and discussed at an IEA-Workshop (April 1991) and at the 5th International Conference on Fusion.

These criteria are:

- Emissions in accident conditions:
  The effects of a realistically conceivable release (RCR) of a LAM used as first wall material should not trespass 50 mSv of early dose. The RCR is assumed to be the atmospheric emission of 10 -100 kg which means a short-term radiotoxicity lower by one or two orders of magnitude than that of steels.

- Robotised maintenance:
  In order to allow prolonged maintenance operations without problems to electronic components, the gamma dose after one day after the reactor shut down should be limited to 104 Gy/h.

- Waste disposal:
  Geological disposal is assumed to be the likely European solution. The contact dose and thermal power of the waste should be limited to 20 ms and 10 wm^3 respectively after a 50 years cooling time.

- Recycling:
  The contact dose after a 100 years cooling time should be limited to 25×10^{-3} mSv.

- LAMs fulfillment to criteria:
  An ideal LAM should fulfill all criteria. If this condition cannot be achieved, materials in plasma facing components should preferentially fulfill short-term criteria, namely those on accidental emissions and maintenance. Materials adopted in the other reactor zones should preferentially fulfill the waste disposal and/or recycling criteria.

Latterly the capability of various candidate structural materials to satisfy such criteria has been assessed.

The conclusions are as follows:

- Steels can hardly be considered as possible low-activation materials. Even the elementally-tailored reduced activation steels can never fulfil completely all criteria.

- Vanadium alloys comply with the accident safety limit. However, they could retain a large amount of tritium which, in the case of environmental release, would give a non-negligible contribution to doses. The maintenance limit is not satisfied whereas the waste management and recycling conditions are complied.

- SiC-fibre reinforced SiC matrices (SiC/SiC) satisfy all criteria related to accident safety, maintenance and waste disposal. Recycling is not considered a viable solution for this kind of material. These conclusions apply to the case of material including fabrication impurities. Therefore SiC/SiC looks at present as the most attractive low activation material.

References

/1/ ROCCO, P., ZUCCHETTI, M. - "Criteria for defining low activation materials in fusion reactor applications" - Fusion Engineering and Design 15 235-244 (1992)

/2/ ROCCO, P., SCHOLZ, H.W., ZUCCHETTI, M. - "Silicon carbide and the new low activation requirements for a fusion reactor first wall" - Proc. ICRFM 5, Journ. Nucl. Mat. in print (1992)

3 EXPLORATORY RESEARCH

ISEI is involved in a number of Exploratory Research projects aimed at exploring new possible lines of research. Several projects involve the use of Neural Networks in applications for Time Series Analysis, for Remote Sensing of Images and in Safeguards use. In the first case the main goals are to realise a network for economic time forecasting and to develop both methods and tools best suited for various kinds of time-series analysis. Another activity is exploring the role of the use of neural network approaches for the analysis of remote sensing data. The safeguards use is looking at the feasibility of seal matching problems encountered in this area.

Another project involves the use of lasers:

- to use laser methods for the identification and quantification of the deterioration mechanisms affecting historical works of art and ancient buildings, and

- a study of ways and means of reducing quantum noise of laser light to improve the resolution of measurements made by laser light beams.

Another area of research is in the field of the exploitation of Biological Adaptive Systems for Process control by the enhancement of fuzzy controllers using Genetic Algorithms. The aim is to carry out a "benchmark" study of three techniques inspired by studies of biological systems, namely Neural Networks, Genetic Algorithms and the Immune network, for the control of dynamic processes.

The last research activity is concerned with the reinforcement connectionist approach for Robot path finding.

3

EXPLORATOTY RESEARCH

NEURAL NETWORKS FOR TIME SERIES ANALYSIS

The main goals of this project were to realise a Neural Network for economic time series forecasting, on one hand, and above all to develop both methodology and tools for designing connectionist models suited for various kinds of time-series analysis (signal processing, adaptive control, aso.), on the other hand.

For economic time series forecasting, which are characterised by relatively slow rates of incoming data, a complete software package for systematic exploration of the neural network capabilities has been written. It has been tested on univariate and multivariate time series, and the results compare quite well with those obtained by more traditional techniques /1/.

In order to deal with higher rates of incoming data, the methodological part has consisted of two studies on different aspects of learning, generalisation or adaptation of multilayer perceptrons.

The first study /2/ deals with the problem of estimating the expected generalisation mean squared error of a trained multilayer perceptron. The estimator is based only on the observed learning set error, thus avoiding the use of a supplementary (data consuming) test set to validate the model.

The second study /3/ results in a new method of incremental or adaptive learning for feed forward neural networks. When a new pattern is presented to a trained multilayer perceptron, the proposed learning algorithm tunes its weights in order to encode perfectly the added example, while seeking for a minimal disturbance of the existing data representation.

References

/1/ VARFIS, A., VERSINO, C. - "Neural networks for economic time series forecasting". Proceedings of "Neural Networks for statistical and Economic data", Dublin, Ireland, December 10-12 1990, pp 155-159 (1990)

/2/ VARFIS, A. -. "An Introduction to Neural Networks". In "Architecture, Programming Environment and Application of the Supernode Network of Transputers" D. Heidrich & J-C. Grossetie eds., Kluwer Academic Publishers, Nov. 1991, pp 197-211 (1991)

/3/ RUIZ DE ANGULO, V., TORRAS, C. - "Minimally Disturbing Learning". In A. Prieto (ed), Artificial Neural Networks: Proceeding s of IWANN '91, Granada, Spain, September 1991, pp 162-172 (1991)

REINFORCEMENT CONNECTIONIST APPROACH FOR ROBOT PATH FINDING

The path finding problem of interest is characterised by:

- a continuous set of robot configurations and robot actions,
- a partially unknown and dynamic environment,
- a need of coping with unexpected events and of making real-time decisions, and
- strong performance demands (i.e. the path must be as short as possible and with wide clearance to the obstacles).

The approach is to develop a reactive system for robot path finding i.e. a system that transforms each perceived situation into the proper action, and iterates this mapping until the goal is reached. The suitable situation-action rules are determined through a reinforcement connectionist architecture where the agent learned by doing. This architecture is appealing because it is simple i.e. the agent only needs a performance feedback computed by itself on the basis of the goodness of the next configuration and how this configuration has been reached and it is also incremental i.e. the agent interacts with its environment since the very beginning and improves as it collects experience.

During 1991 a prototype has been completed for a point robot in a 2D environment with circular obstacles. Simulations have proven that the prototype:

- learns quickly,

- exhibits good noise-tolerance and generalisation capabilities, and

- copes with dynamic environments.

The codification scheme adopted and the algorithm used to discover stable solution paths are strongly responsible for these positive features. Work related with this prototype is described in /1/2/4/5/6/. In the second half of 1991, work has focussed on 2D mobile robots with 3 degrees of freedom operating in 2D environments with polygonal obstacles. The architecture of this new prototype, even if it is a bit more complex than the previous one, allows to learn extremely quick because of:

- the integration of one-step planning and reaction,

- a mechanism for one-shot learning,

- the modularity of the network, and

- constructive techniques for adding new units and links to the network whenever it is necessary to improve the performance.

In the frame of this first year of exploratory research, a Collaboration Agreement was made between ISEI and the Superior Council of Scientific Research in Spain (contract number 4356-91-05-TS ISPE).

Another spin off of this exploratory research was the application of connectionist techniques to robot kinematic calibration /3/.

References

/1/ MILLAN, J., DEL R. TORRAS, C. - Connectionist approaches to robot path finding. In O.M. Omidvar (ed.), Progress in Neural Networks Series, Vol 3. Norwood, NJ: Ablex (1991a)

/2/ MILLAN, J. DEL R. TORRAS, C., BECQUET, M. -. Autonomous mobile robots and teleoperation. In M. Becquet (ed.), Teleoperation: Numerical Simulation and Experimental Validation. Dordrecht, The Netherlands: Kluwer (1991)

/3/ MILLAN, J. DEL R. TORRAS, C. - Robot path finding in non-maze-like environments. Machine Learning, to appear (1991b)

/4/ MILLAN, J. DEL R. BECQUET, M. -. A reinforcement connectionist path-finder. Proc. 6th International Conference on CAD/CA M, Robotics and Factories of the Future (1991)

/5/ MILLAN, J. DEL R. TORRAS, C. -. Learning to avoid obstacles through reinforcement. In L. Birnbaum & G. Collins (eds.), Machine Learning: Proceedings of the 8th International Workshop, 298-302. San Mateo, CA: Morgan Kaufmann (1991c)

/6/ RENDERS, J.-M., MILLAN, J., DEL R. BECQUET, M. - Non-geometrical parameters identification for robots kinematic calibration by use of neural network techniques. Proc. of the European Robotics and Intelligent Systems Conference (1991)

NEURAL NETWORKS FOR REMOTE SENSING IMAGES

The activity aims at exploring the potential role of the use of neural network approaches for the analysis of remote sensing data. It is done in collaboration with the IRSA and splits up into two different application studies using two different data sets. Time series of the upwelling phenomena off Northwest Africa (windfield and sea surface temperature) is one of these studies, while the second uses spectral data from Landsat and Spot for classification purposes.

Useful results have been achieved under the two main study themes, as follows:

Correlation studies of wind/sea temperature.

The important data pre-processing phase and the design of the generic neural network model have been carried out. Many specific experiments have highlighted the potential role of neural nets as a tool

for studying the complex relationship between wind conditions and upwelling signal. By toying with the network's architectures, the following problems have been addressed: The time delay between trigger wind and consequent upwelling. The spread and location of relevant winds for upwelling coming out. The influence of wind intensity and/or direction on the upwelling phenomenon.

Pattern recognition and classification of remotely sensed imagery.

Multilayer perceptron networks have been developed to classify two-date multispectral SPOT imagery over two test areas of approximately 100 sq. km. in France. The accuracy achieved has been of the order of 85% for 20 land cover classes, crops etc., exceeding the accuracy obtained in tests with conventional maximum-likelihood classifiers by about

30%. Quite large networks have been successfully developed for this purpose with about 100 neurons and 2000 interconnections. Initial problems with training such networks have been successfully overcome. The results have been filmed by the BBC for a television programme.

References

/1/ KANELLOPOULOS, I., VARFIS, A., WILKINSON, G.G., MEGIER, J. - (To be published) "Land Cover Discrimination by Neural Network". International Journal of Remote Sensing.

/2/ KANELLOPOULOS, I., VARFIS, A., WILKINSON, G.G. - "Spot image classification by Neural Networks: first 20 classes results" - Technical Note 188.I.91.08. January 1991 (1991)

/3/ KANELLOPOULOS, I., VARFIS, A., WILKINSON, G.G., MEGIER, J. - "Classification of Multi-data Satellite Imagery". Proceedings IG ARSS-91, Finland, June 1991 (1991)

/4/ KANELLOPOULOS, I., VARFIS, A., WILKINSON, G.G., MEGIER, J. - "Classification of Remotely-Sensed Satellite Images Using Multi-Layer Perceptron Networks". Proceedings of the 1991 International Conference on Artificial Neural Networks (ICANN-91), Espoo, Finland, 24-28 June 1991, pp 1067-1070 (1991)

NEURAL APPROACH TO THE MATCHING PROBLEM OF SEALS IN NUCLEAR SAFEGUARDS

This study addresses the feasibility of a neuronal approach to the matching problem of seals in the JRC fissile material programme and has been concluded in September 1991. For this first, and original application according to neural scientists, a performance of 81% has been reached on a sample of seals provided by the JRC. This performance can be increased with a larger data base. The main interest resides in the processing of the data in order to get invariance under rotation and translation which are the bottleneck of classical approaches. These properties are the main characteristic of the neuronal approach. Some suggestions raised during this preliminary study show that an holographic implementation with a very high compression is also feasible.

EXPLOITATION OF BIOLOGICAL ADAPTIVE SYSTEMS FOR PROCESS CONTROL

This research activity aims to carry out a "benchmark" comparative study of three adaptive techniques inspired by studies of biological systems, namely Neural Networks (NNs), Genetic Algorithms (GAs) and the Immune Network (IN), for the control of dynamic processes. This benchmark exercise consists of three case studies of different levels of complexity, namely a simple tank, a cart-pole and a simulated robot. The case studies differ in the physical and theoretical systems that the adaptive mechanisms have to control and regulate. All of them are systems hard to control by means of conventional adaptive control. Each exhibits at least one of the following characteristics: non-linearity, instability, inverse-instability, unmodelled dynamics and unstructured perturbations.

These case studies demonstrate the ability of all three techniques to control simple physical processes both under nominal conditions and in degraded environments with unexpected modifications of process dynamics.

The analysis performed so far shows that:

- NNs are excellent for approximating - and therefore controlling - non-linear processes. However these processes must exhibit the following characteristics: full observability; full controllability; characteristics slowly varying compared to the "response-time" of NNs.

- GAs and IN show similar characteristics (both being special cases of combinatorial search algorithms). Since any control problem can be seen as an optimisation task, both techniques do indeed enable reasonably accurate control.

- For GAs and IN the best control is obtained through hybrid methods. These methods involved the combined use of GAs or IN with another control technique (e.g. traditional control system, NNs or fuzzy control system).

Concerning the last point, a specific research action has been carried out to investigate the potential use of Genetic Algorithms to discover dynamically - and adapt to a changing environment - the control rules of a physical system. This would enable a "fuzzy controller" to control more accurately the systems concerned.

References

/1/ NORDVIK, J., RENDERS, J. - Genetic Algorithms and Finite-State Automation Discovery: Potential Applications to Adaptive Process Control. In: Proceedings of the Intern. Symposium on Distributed Intelligence Systems, IFAC, 14-15 August 1991, Arlington, Va. (USA) ,128-132 - ORA/PRO 35984

/2/ NORDVIK, J., RENDERS, J. - Genetic Algorithms and their Potential for Use in Process Control. A Case Study. In: Proceedings of t he 4th Intern. Conference on Genetic Algorithms, 13-16 July 1991, San Diego, Cal. (USA), Morgan Kaufmann Publs., R.K. Beleko and L. B. Booker (Eds.) - ORA/PRO 35985

/3/ RENDERS, J., MILLAN-RUIZ, J., BECQUET, M. - Non-Geometrical Parameters Identification for Robots Kinematic Calibration by Use of Neural Network Techniques. In: Proceedings of the European Robotics and Intelligent Systems Conference (NTUA), 23-28 June 1991, Corfu (GR), Kluwer Acad. Publ. - ORA/PRO 36277

SURFACE STATE IDENTIFICATION BY LASER LIGHT

Objective: Development of laser light methods for the identification and quantification of the deterioration mechanisms affecting historical artworks and monuments.

Experimental work has been devoted to the assessment and the development of techniques able to measure the shape and the roughness of the surface of stone materials. The theoretical work and the laboratory tests carried out on stone specimens (from Milan Catheadral) have shown that an object-dependent, properly fitted combination of the holographic contouring and optical correlation techniques can lead to the geometric characterisation of a surface with resolution ranging from millimetres down to micrometers. Optical fibres were successfully used to simulate field test conditions where the direct illumination of the monument may not be possible.

Fig.3.1 shows the 3D map of the defected surface of a sandstone piece as obtained by computer processing of holographic contouring data /1/.

The many contacts with external laboratories are leading to the creation of a network of laboratories on Application of Optics and Related Methods for the Protection of Cultural Heritage.

References

/1/ LUCIA, A.C., ZANETTA, P., ALBRECHT, D., FACCHINI, M., ZRN, M. - "Conservation of works of art: diagnostic methods by laser holographic techniques" - Technical Note ISEI/SER (in press)
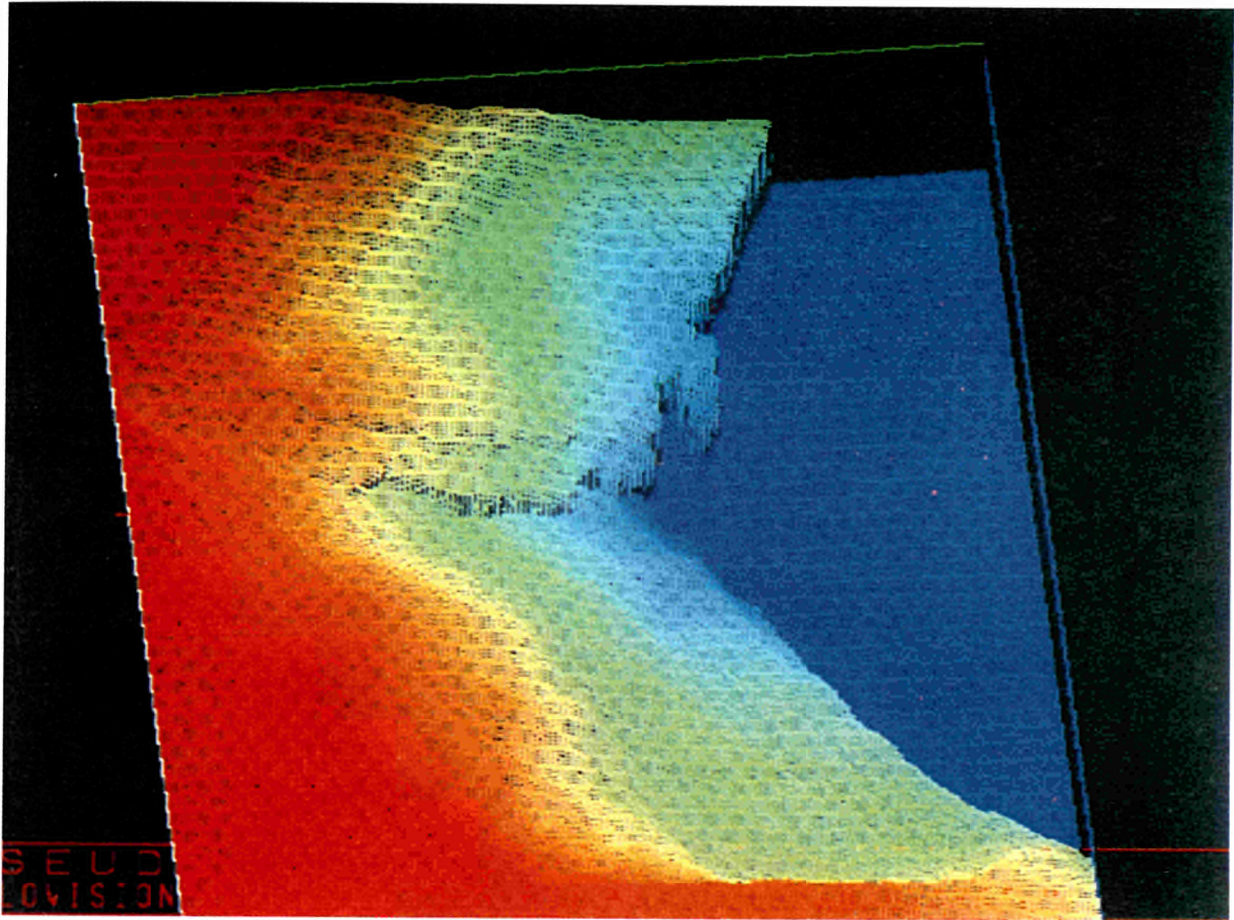
Fig. 3.1: Map of a defected surface of a sandstone piece.

LIGHT SQUEEZING TECHNIQUES

Objective: Reduction of quantum noise of laser light to enhance the resolution of measurements made by laser light beams.

The study of the fluctuations of electromagnetic fields and their equivalence with stationary regular processes has been completed. Experimental set-up: calibration tests are near to completion.

Preliminary tests on the coupling of two incoherent laser beams on a non linear optical material led us to the development of two new interferometric sensors, already described in the chapter on FWP Measurement and Testing.

Patents

- Detecteur interferometrique hyper sensible, N. P/2319
- Modulateur tout-optique, N. P.2348.

THIN-FILM PHOTOVOLTAIC DEVICES IN BUILDINGS

The objective of the work is to assess the potential of thin-film Photovoltaic devices as window material for buildings. Focus is the development of testing methodologies in order to maintain the leading position of ESTI in PV technolgy qualification.

Based on a market survey, two technologies were identified as possible window material, one being conventional, large area thin-film deposition, the other a double-glass thermal insulation sandwich, the front glass serving as substrate for the thin-film deposition. Spectral response and reflectivity measurements on industry samples proved that the transparency and appearance of the window can be contraolled by the thickness of the i-layer (insulating Si between the p and n doped layer) In collaboration with industry, samples are measured with respect to establishing the best compromise between transparency and photovoltaic efficiency.

4 SUPPORT TO THE COMMUNITY POLICIES

Support to International Cooperation

Support to the Community Industrial Policy

Support to the Community Transport Policy

Support to the Community Development Policy

Support to the Community Environmental Policy

Support to the Community Telecommunications, Information and Industrial Innovation Policy

Support to the Community Energy Policy

Support to the Community Statistical Office

Support to the Secretariat General of the Commission of the EC

The ISEI support to the Community policies in divided into nine areas:

- Support to International Cooperation, where work is done in support of both DG I and IAEA in the areas of nuclear material accountancy, surveillance techniques, sealing and identification techniques and volume/mass determination.

- Support to Industrial Policy is concerned with the World Shipbuilding data bank, where the aim is the production of statistical tables on worldwide ship building.

- Support to Transport Policy where a comparison is made of existing data banks and reporting systems, dealing with aircraft incidents. A feasibility study is underway on the setting up of a European Coordination Centre for Aircraft Incident Data Base.

- Support to Development Policy in the solar energy area.

- Support to Environmental Policy, in the areas of major accident hazards, biotechnology hazards and civil protection.

- Support to Telecommunications, Information and Industrial Innovation Policy. Work here has included the Advanced Networking support, the use of Distributed Artificial Intelligence for building problem solving, parallel computing applications within the ESPRIT context, secretarial assistance to COST activities and work on the VALUE programme for 3D image processing and solar technology transfer.

- Support to energy policy, both nuclear and non-nuclear. The nuclear tasks were to give technical support to Euratom safeguards. The non-nuclear work was in connection of the DG XVII THERMIE award scheme for energy saving in buildings and transport, and with solar energy (thermal and photovoltaic).

- Support to the Statistical office in Luxembourg with the statistical application of Artificial Neural Networks in problem solving.

- Support to the Secretariat General of the Commission in anti fraud coordination. This involved a feasibility study for a a computer documentation system containing descriptions of national anti-fraud systems in the EEC, and in the setting up of a data base for the management of petitions presented to the European Parliament.

SUPPORT TO THE COMMUNITY POLICIES

SUPPORT TO INTERNATIONAL COOPERATION

The Commission's technical support programme to IAEA was established in 1981, and 16 specific tasks have been defined and they are performed in several Institutes of JRC, namely CBNM, ISEI, IST, ITU.

ISEI acts as the coordinator of the JRC's effort in respect to IAEA. Furthermore ISEI performs activities in the areas of:

- Nuclear Materials Accountancy
- Surveillance Techniques
- Sealing and Identification Techniques
- Volume/Mass Determination

Support to DG I/IAEA

In the field of optical surveillance for safeguards two collaboration tasks with the IAEA were active in 91: one related to the development of image processing for video tape review and the other concerning modular laser surveillance systems.

Optical surveillance based on video or laser techniques plays an important role in storage areas of nuclear material since it allows to reduce manpower in inventory verification.

Image processing for tape review

The increasing amount of recorded video pictures makes the review process laborious and points to the use of computerised vision systems for the partial automation of the reviewing task. Currently, the IAEA has to review several million images per year. Therefore, ISEI has developed an image processing system which detects scene changes in pre-defined areas of interest /1/. To obtain the necessary speed, the detection algorithm operates on a subset of pixels called polylines. The user can define such polylines in any shape in any position. Three detection algorithms have been implemented based on cross-correlation of the polylines, on their normalised means or on their normalised variances. Masks with logical combinations of polylines that must simultaneously detect a change to trigger an alarm can be defined. Secondary detection marks have been added in order to detect movements in a given direction within certain speed limits (Fig. 4.1).

The system has been configured for reviewing video tapes either in European or American standard. In August 1991 extended tests at the IAEA Headquarters using real video tapes recorded in plants have been carried out on three different image processing systems. The ISEI system showed the best results for detection capability and data reduction.
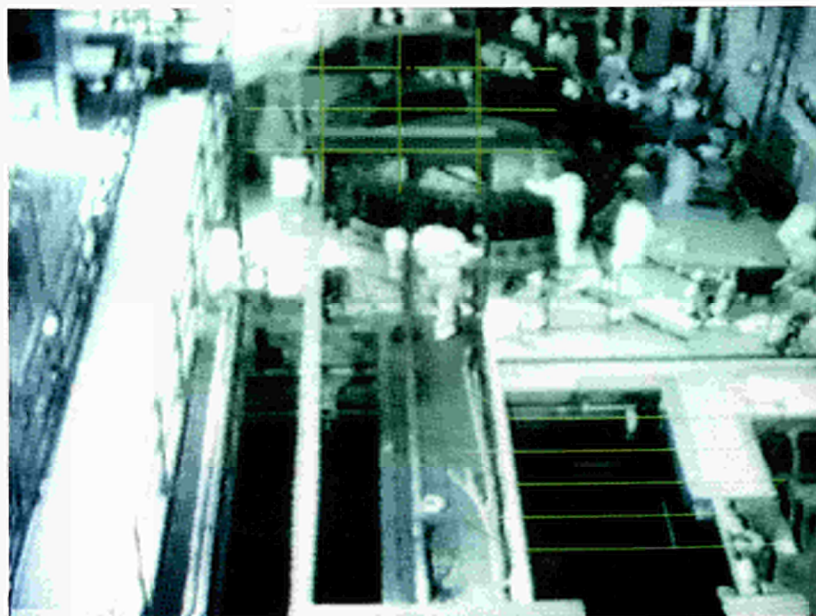
Modular laser surveillance system

The laser technique has been applied to surveillance in air and underwater operation using the LASSY system. The field tests of a combined system laser-video have been carried out during 1991 in a storage facility. Important modifications have been made to the mechanical assembly of the rotating laser eye as well as to the software structure. A detailed report on the results was distributed to the IAEA and interested laboratories /2/.

Fig. 4.1: Surveillance picture with inserted polylines in areas of interest.

The applications of laser underwater have been investigated. The infrared laser was substituted by a new laser in the blue range because of its low absorption in water. Extensive tests have shown that this technique is not suited for safeguards purposes since it can be tampered /3/. Another application consists in the determination of the water quality since the laser system gives a precise measurement of the concentration of suspended matter. This task with IAEA is now completed.

References

/1/ MOL, M. - "Image processing methods for scene change detection and motion detection", ESARDA Bulletin, may 1991

/2/ SOREL, F. - "Final report on LASSY tests in Fiat/Saluggia" - Technical Report, may 1991

/3/ SOREL, F. - "Applications of LASSY underwater" - Technical Report, June 1991

Sealing and Identification Techniques

IAEA is requiring a more extensive use of ultrasonic techniques for the underwater sealing seal verification of spent fuel containers or for the identification of casks. Several laboratories are developing such techniques and more particularly in Canada (Atomic Energy Control Board - AECB) for CANDU fuel and in the U.S.A. (Sandia National Laboratory - SNL). In order to harmonise the developments in JRC and in the above mentioned laboratories, a tripartite project called: In-situ Readable Ultrasonic Seal System (IRUSS) has been set up with the aim of developing a single instrumentation which could be used by inspectors on different types of ultrasonic seals (for instance: CANDU spent fuel stacks and LWR spent fuel transport/storage containers).

Detailed design specifications have been formulated among the involved parties which should lead to a standard inspection procedure. A longer term study is underway concerning the interface between on-site verification data and headquarters data base.

In cooperation with the French support programme to the IAEA, an ultrasonic identifier prototype to be applied on spent fuel transport casks has been studied and tested successfully in "quasi-real" conditions. A field test on real casks is waiting for licensing authorities approval.

Reprocessing Plant Measurement Techniques

The laboratory scale tank (200 l) measurement laboratory has been transferred from IAEA Vienna to the Ispra LaSCo laboratory. This laboratory is intended for the evaluation of the performances and training in use of volume and weight measurement systems in liquid tanks. The pneumatic and liquid circuitry has been installed and the first calibration of the measurement equipment has taken place.

Regarding the large tank measurement laboratory (TAME), mentioned earlier in this report, several discussions with measurement experts have taken place to define the requirement from the IAEA inspectorate for validation of measurements and training of inspectors.

Finally ISEI has participated in the analysis of the technical features of PETRA, installed at IST which could be of interest for nuclear safeguards. They are mainly related to liquid level measurements, development of authentication techniques for sampling and measurements and assessment of performances of techniques for determination of nuclear materials in waste streams.

Knowledge Based System for Transit Matching

One of the responsibilities of the IAEA is to confirm the receipt of international shipments of nuclear material by matching shipments reported by one Member State against receipts reported by another Member State. An expert system, Computer Assisted Human Matching (CAHM) has been designed and implemented to reduce substantially the manpower required in the phase of Human Transit Matching. This new system is integrated within the ISIS data bank, and has completely substituted the previous manual matching system for non proliferation treaty (NPT) countries. Some enhancements have also been made to the CAHM expert system to include new rules concerning the inventory change correction treatment. The task is completed. The IAEA has submitted a new task to integrate the Transit Matching activities for NNPT countries within the CAHM system.

Application Development in New ISIS Environment

The Computerised Inspection Report data entry system (CIR) is being completed in a new ADABAS-NATU-RAL fourth generation environment and the new system is now in routine production operation. The basic function of CIR system is to provide information for analysing inspections, and for preparing inspection statements to Member States, but there are other sources of information concerning the inspection activities that are not included in the CIR system. For example the Equipment Information System (EQUIS) is a collection of information concerning the Inventory and Management of Safeguards Equipment. An effort has been made to rationalise the EQUIS system, and now EQUIS is accessible through the Local Area Network to permit real time processing of safeguards equipment. The next phase of this task is to include quality control features which is an important aspect of the performance evaluation of the whole EQUIS system. In addition, considering that the data collection for equipment should be used in CIR for updating the equipment status in EQUIS, it will become necessary to integrate EQUIS within CIR.

SUPPORT TO THE COMMUNITY INDUSTRIAL POLICY

World Shipbuilding Data Bank

The objective of the work is the production of statistical tables (quarterly, annual and historical) on world shipbuilding production, by ship type, size and flag. The aim is to supply this information to DG III, independent of national bodies, to be used for the preparation of an annual report from the Commission to the Council of Ministers.

In 1991 the most important part of the bank was downloaded from the main frame to a PC. Some changes have been made to take into account the unification of the F.R.G. and the D.D.R. The complete adjustment of new orders and, particularly, of cancellations of the D.D.R. shipyards will be possible only at the beginning of next year. Some work was done on the graphical and statistical representation of the data. The development of statistical methods for regression analysis of production trends is in progress. The floppy disks production procedure was completed, but the distribution list has, up to now, not been reestablished. Distribution to selected partners was started to test the procedure, with satisfactory results. The work for the introduction of new building prices awaits the price data (to be supplied by DG III) which are currently not available. No allocation of new c.g.t. (compensated gross tons) was necessary (no changes decided by OECD).

SUPPORT TO THE COMMUNITY TRANSPORT POLICY

Aircraft Incident Data Base

The objective of the project is a comparison of the existing Data Banks and reporting systems for aircraft incidents and an analysis of their compatibility. This includes a feasibility study and design of a European Coordination Centre for Incident Data Bases.

A Steering Group (composed of experts from the Member States already having mandatory reporting systems) was set up to assist ISEI in the work. A first review of the existing mandatory Incidents Reporting Systems has been made in the course of a meeting of national Civil Aviation Authorities (CAA) held at Ispra. The benefit of setting up a central standardised data base, as well as the interest of having a neutral organisation (e.g. the JRC) tackling the basic research aspects and the long term data analysis was recognised. The guidelines were defined of the architecture of a possible central database managed by a European Coordination Centre. A questionnaire was prepared and sent to national CAAs to collect more detailed information about the existing systems while the preparation of a draft project was started.

SUPPORT TO THE COMMUNITY DEVELOPMENT POLICY

Non Nuclear Energy

The ISEI gave general support and assistance to the "Solar Regional Programmes", set up by the Directorate General for Development (DG VIII) within the framework of the Lomé Convention. These programmes are part of the European Development Fund. Pre-consultancy studies for regional energy programmes and technical reports from current projects were analysed and a feasibility study was started, on the use of solar energy in buildings and agriculture, for the countries of the Sahel and the Pacific Ocean region.

SUPPORT TO THE COMMUNITY ENVIRONMENTAL POLICY

Major Accident Hazards

The CDCIR (The Community Documentation Centre on Industrial Risk) has become the "core" around which the overall activity is organised and expanded *(Fig. 4.2)*. The common interest of the different works lie in the process of exchanging information and comparing national approaches for a consensus achievement of a harmonised implementation of the "Seveso" Directive (82/501/EEC).

- Bulletins (5 issues) have been regularly issued and distributed to about 500 interested organisations.

- a service for responding to the requests of information by external users is being organised.

- the publication of comparison studies on national approaches and safety regulations has been promoted.

The main objective of the MARS system was the achievement of a structured exchange of information among the competent authorities, useful for improving the accident prevention policy. The analysis of the accidents notified to the Commission has now resulted in a comprehensive report on "Lessons Learned" /1/3/. The study confirms the role of managerial and organisational failure as the root causes of the large majority of the accidents.

Other activities have been directed to increase the knowledge base of the Community, by analysing relevant national experiences. A detailed comparison of national approaches to the safety notification

Fig. 4.2: Reports of the CDCIR.

has been included for diffusion into the CDCIR /2/. A first study on the experience gained by handling chemical accident emergencies in the U.K. has been completed. Similar studies have been finalised for FRG and France and are being published. A comparison of safety regulations concerning LPG installations has been completed and is being published in

the CDCIR series. Studies on Risk Information procedures in UK, DK, F and NL are being finalised.

Risk Communication - Seveso Directive, 82/501/EEC and Amendments, Art. 8

A number of reports have been produced for the regular meetings of the National Competent Authorities in Brussels. These include:

- An evaluation of the research sponsored by the Commission concerning emergency organisation response, public emergency behaviour, risk perception and risk communication /4/. This evaluation generated a number of recommendations for information policy and research.

- An exploration of the literature regarding socio-organisational aspects of risk management and risk communication. This has concentrated on the nature of scientific information and its role in the communication process. Scientific and institutional uncertainty are central issues of this process.

- A proposal for a two-tier information strategy. The first corresponds to the "technical" information which can be standardised, and is common to all the Member States. It contains, for example, the names of the substances and the risks associated with them. It reflects closely Annex VII of the amended Directive (88/610/EEC). The second is "pragmatic" information which is contextual and reflects the specific characteristics of a particular site. These refer to the "how" of communication rather than to the "what".

- A proposal of guidelines, concerning "technical" information, is being drafted on the basis of the previous work. These guidelines are to be presented to the national Competent Authorities for discussion.

All the national Competent Authorities and industrial associations have been approached in order to collect first hand information about their activities in risk communication. With some a working relationship has already been established.

References

/1/ DROGARIS, G. - Major Accidents Reporting System. Lessons learnt from Accidents notified, CDCIR, EUR 13385 EN (1991)

/2/ AMENDOLA, A., CONTINI, S. - National Approaches to the Safety Reports: A Comparison, CDCIR SP-I-91-07, January 1991

/3/ DROGARIS, G. - "Extraction of Lessons Learned from Accident Data Bases", paper presented in the OECD Workshop on the Prevention of Accidents Involving Hazardous Substances: The Role of the Human Factor in Plant Operation, OECD, Tokyo, April 1991

/4/ DE MARCHI, B. - Comunicazione ed accettabilità del rischio, convegno 3ASI Milano, Settembre 1991

Biotechnology Hazards

After the adoption of the Directives, (23 April 1990) on the contained use of Genetically Modified Microorganisms (GMMs) and on the deliberate release of Genetically Modified Organisms (GMOs), ISEI has cooperated with DG XI on the clarification of the relevant technical issues which need to be solved for a sound implementation of the Directives /1/2/.

Among the topics addressed, particular importance has been given to the discussion of:

- principles of good working practices such as GMP (Good Microbiological Practice) and GILSP (Good Industrial Large Scale Practice);

- classification of GMMs according to potential hazards;

- criteria for assessing pathogenicity of GMMs;

- procedures for safety notifications for contained use of GMMs and deliberate release of GMOs.

References

/1/ CAMPAGNARI, F., SCARAMELLA, V. (eds.) - Scientific-Technical Backgrounds for Biotechnology Regulation Proceedings of EUROCOURSE held at Ispra on June 1991, Kluwer Ac. Publ. in press (including: G. Van Den Eede: Basics of plant gene transformation)

/2/ VAN DEN EEDE, G., VAN MONTAGU, M. - Applications of genetically engineered micro-organisms in agriculture. In R.H. Bishop "Proceedings of the Second International Conference on the Release of Genetically Engineered Micro-organisms" Plenum Publishing, London (in press) (1991)

Civil Protection - Pilot Communication and Information System

Following the general design of the pilot civil protection information system, implementation work started in January 1991. ISEI, in its role as project leader, organised bimonthly working meetings to monitor progress and participated in the project's Steering-Committee meetings.

In collaboration with staff from the Informatics Directorate (Lux.) all design documentation from the previous phase was reviewed, corrected and accepted.

A detailed plan for the implementation phase (a document with detailed definitions, guidelines and constraints for all work packages) was completed and accepted in July 1991.

A demonstration of the first deliverables of the project including the graphic user interface, gateway access to external systems, electronic mail and bulletin-board, and the online databases (including the Vademecum, the Inventory of existing information systems, and information on the national contact points) has been scheduled for January 1992, when the national civil protection correspondents will meet in Brussels.

SUPPORT TO THE COMMUNITY TELECOMMUNICATIONS, INFORMATION AND INDUSTRIAL INNOVATION POLICY

Advanced Networking-Support

The objective of this activity is to: provide technical and organisational support to network for the European R & D community, promotion of user groups applications exploiting pan-European services and pilot products from industry, provide technical advise for planning.

In 1991 the following work has been performed:

- Planning & reviewing the IXI European X.25 backbone network connecting all national academic networks.
- Planning & reviewing the Y-Net Pilot OSI service for European R&D and SMEs.
- Planning & reviewing ESPRIT projects in the field of photonic networks, frame and cell switches, metropolitan area networks, high performance protocol standards.
- Contributing to the launch of the Cost 14 action on cooperation technologies including multimedia groupware.
- Planning the intercontinental network infrastructure for US-Europe R&D collaboration.
- Technical secretariat of the Ercoftac International Association on flow, turbulence and combustion.

Support to Training Courses

The objective of this activity is to organise training courses and summer schools in order to contribute to the dissemination of ESPRIT results.

In 1991, one summer school was given under the scope of the JRC Eurocourses activity. The course was entitled "Distributed Artificial Intelligence - Theory and Praxis". This was connected to the DG XIII support activity for the ARCHON project. There were 40 participants (about 50 requests for registration were received).

Persons from more than 5 different ESPRIT projects participated at the Eurocourse which included workstation-based example and demonstration sessions. Grants were awarded to 10 student participants. A book of the proceedings of the summer school is in preparation.

Distributed Artificial Intelligence

Distributed Artificial Intelligence (DAI) is the area of Computer Science which deals with building problem solving computer systems based on distributed multiple agent architectures. The field of DAI is subdivided into two areas: distributed problem solving (DPS) and multi-agent systems architecture (MAS) in

both of which ISEI has an on-going activity. DPS studies the characteristics of sets of problem solving modules that work together to solve problems beyond their individual capabilities. MAS architectures are based on collections of semiautonomous computational elements, called agents, located in a number of distinct processing nodes coordinating their knowledge, goals, skills and plans jointly in order to take action. In the context of the ESPRIT II project KWICK a distributed problem solving (DPS) system is designed that can support various aspects of the everyday work of a scientist. In the area of multi-agent systems ISEI has an on-going activity through two projects:

- project ARCHON which deals with design of intelligent industrial supervision and control systems and the project CASE-Support which deals with tools for DAI systems design.

KWICK: Project Outline

The aim of KWICK is to build a computer system that provides scientific and technical knowledge workers, such as researchers and engineers, with an environment to improve their productivity and the quality of their work.

Based on the distributed client-server architecture, KWICK provides easy access to information and knowledge sources (books, scientific publications, visual information other than text, etc.) and computational resources (mathematical and statistical packages, theorem prover, etc), offers a range of support services (a special editor for scientific publications, an annotation editor, etc.) and uses various advanced technologies such as artificial intelligence and hypermedia.

Hypermedia systems are very powerful to present information to their users in a way that can be easily understood and explored.

The two main tasks in the project were: to design and prototype the central control system and to build a prototype application, demonstrating the KWICK technology. To assist someone in the execution of his work hypermedia by themselves are not sufficient and need to be integrated with intelligent systems that support the organisation, coordination and communication aspects of the work.

KWICK: The distributed problem solving architecture

The two main achievements in KWICK are:

- a generic framework for distributed problem solving and
- a prototype of an electronic multimedia safeguard system.

Following a thorough survey of DAI literature a mixed DAI architecture was proposed for the KWICK problem solving system. The primary architecture being one of a DPS system, was enhanced with typical components of a MAS, such as automatic planning of the problem solving and negotiation between the individual problem solvers. This architecture was presented in /13/. The description of this architecture served as the basis for the first prototype which, during the year 1991 was enhanced and has become a generic framework for DPS, shown in the picture (Fig. 4.3).
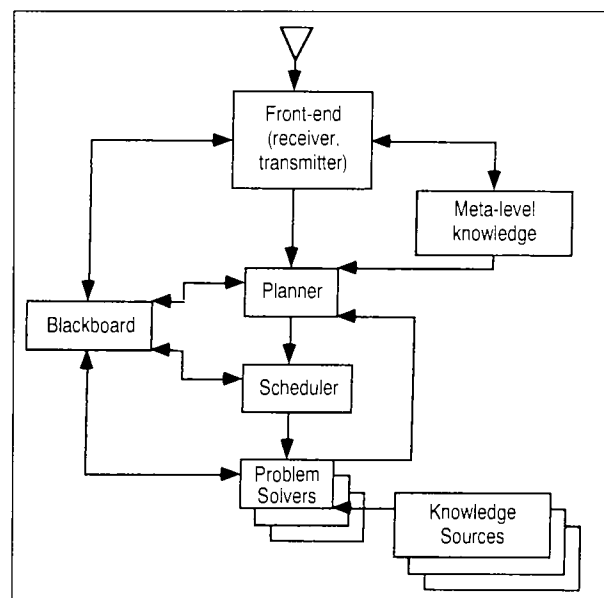

Fig. 4.3: Organisation of a node in a PDS system

The designed system deals with requests for solving problems. Models of the individual problem solvers are stored in the meta-level knowledge in order to establish a plan to solve a given problem. A plan can include several paths, each of which can lead to

a solution. Each path contains a combination of problem solvers that contribute to the solution. Once the plan is established, the system will look for the best path, taking into account estimates for the cost of finding a solution and the quality of the obtained result. Once defined the optimum path, the problem solvers of that path will be scheduled.

During problem solving it might be necessary to replan problem solving due to the real cost of execution and the quality of the actual result provided. A prototype of the system described has been built which performs intelligent information requests handling in combination with the KWICK annotation editor.

The use of this kind of DAI architecture is a major breakthrough in comparison with traditional architectures. It provides high reusability, reconfigurability and integratability of the individual components due to the separation between the organisation of the problem solving process and the problem solving itself. DAI architectures are also well adapted to the distributed nature of actual computer networks. The

automatic planning facility uses high level models of the individual problem solvers, to generate a plan that leads to a solution of a problem. Such a plan consists of several alternative paths, that can all provide a solution for the same problem. It estimates the cost of alternative paths and the quality of the result they provide. Costs and quality result are matched with the users criteria for problem solving in order to decide which path to follow. The DPS framework continuously enhances the problem solving performance through built-in learning mechanisms. The results and the experience of this research are described in /14/.

KWICK: The safeguards demonstrator

The prototype of the electronic multimedia safeguard system demonstrates how a KWICK-like environment supports the work of inspectors of the Nuclear Safeguard Authority. The Nuclear Safeguard Authority is involved in the assurance of the application of the Treaty for Non Proliferation of fissile material. The
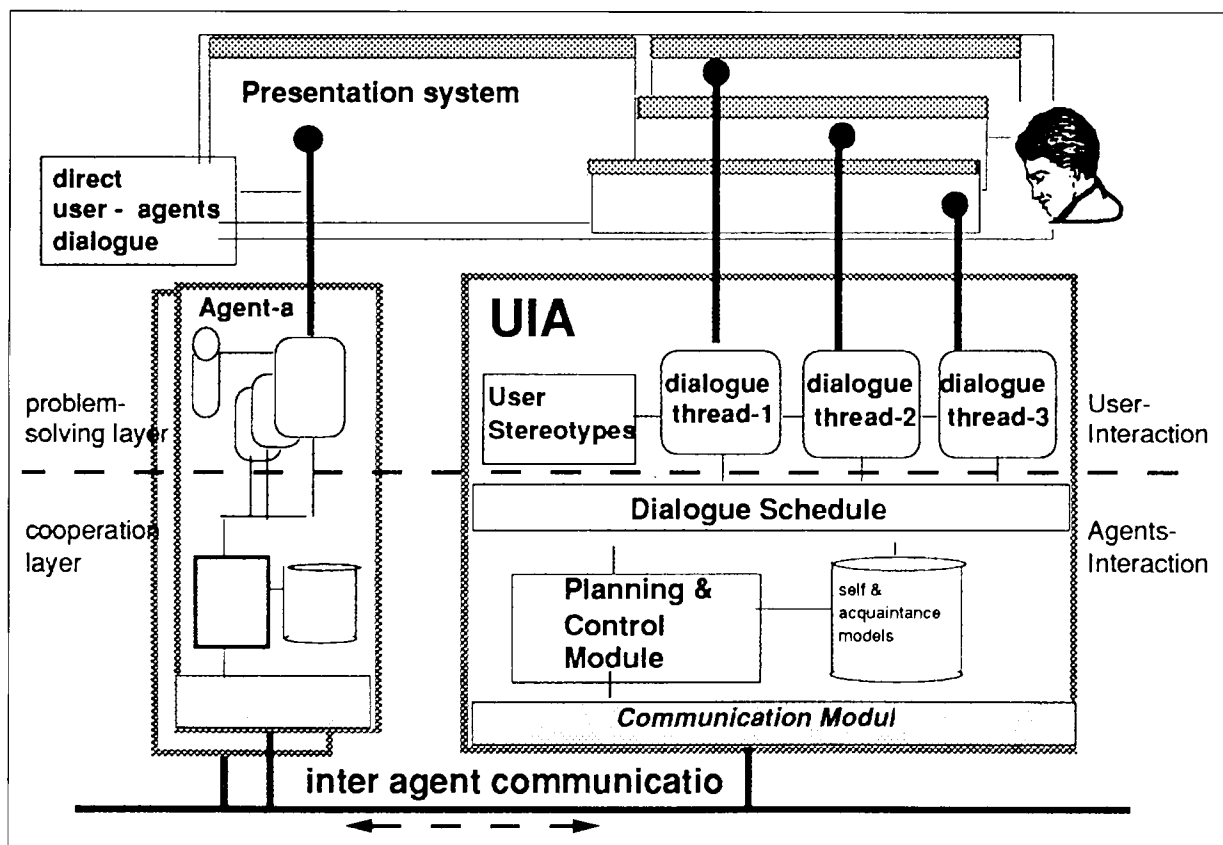

Fig. 4.4: Architecture of the generic UIA. The problem solving layer of UIA manages dialogue with the presentation system (user), while the cooperation layer controls interaction with the agents of the system.

inspectors have to check accounting reports provided by facilities handling fissile material (monthly reports on the input and output flow of fissile material, stock reports, etc.) against other information gathered by the Safeguard Authority (stock control reports, video images of storage locations, etc.) and existing regulations. The multimedia safeguard system provides access to the different sources of information such as the accounting reports, the control reports and the existing regulation documents. It also provides access to video images of the plants under control of the safeguard authority.

ARCHON: DAI systems end-user interface design

ARCHON (Architecture for Cooperating Heterogeneous Online Systems) is a five-year ESPRIT project (1989-1993) which aims at the study and development of an architecture for cooperating expert systems and demonstration of its applicability in the domain of industrial process control. ISEI has the task of studying human-computer interaction with the end-users of ARCHON applications and designing the interface to the ARCHON development environment. The main features of DAI work in ISEI are described in /2/ and /4/.

The design of end-user interfaces to DAI systems is based on the User Interface Agent (UIA) concept. This is a component of the multi-agent system that has two main functions: To represent the agents and their

contribution in the problem solving to the user in a way consistent with the users conceptual view of the system and to model and represent the user within the system, in a way that all agents have an interlocutor when user interaction is required, despite the fact that the user might not be aware of their existence.

The generic UIA architecture has been completed this year and can be seen in *Fig. 4.4*. It contains two parts, as any other ARCHON agent: the cooperation layer which controls interaction with the other agents (application agents) and the problem solving layer. The latter has the task of managing interaction with the user. The complexity of the agent interaction part depends on the multi-agent system characteristics while the structure of the user interaction part of UIA depends on the particular application requirements. An example of a UIA has been built for an electricity management and control application (Iberdrola, Bilbao, Spain).

The architecture of the UIA is described in /4/ and the Iberdrola prototype in /5/.

ARCHON: Multi-agent system Developer interface

The ARCHON developer interface is based on graphical representation of multiple flexible views of the multi-agent system. These are achieved through the Developer Agent (DA). In the current phase of design, DA supports visualisation of the multi-agent
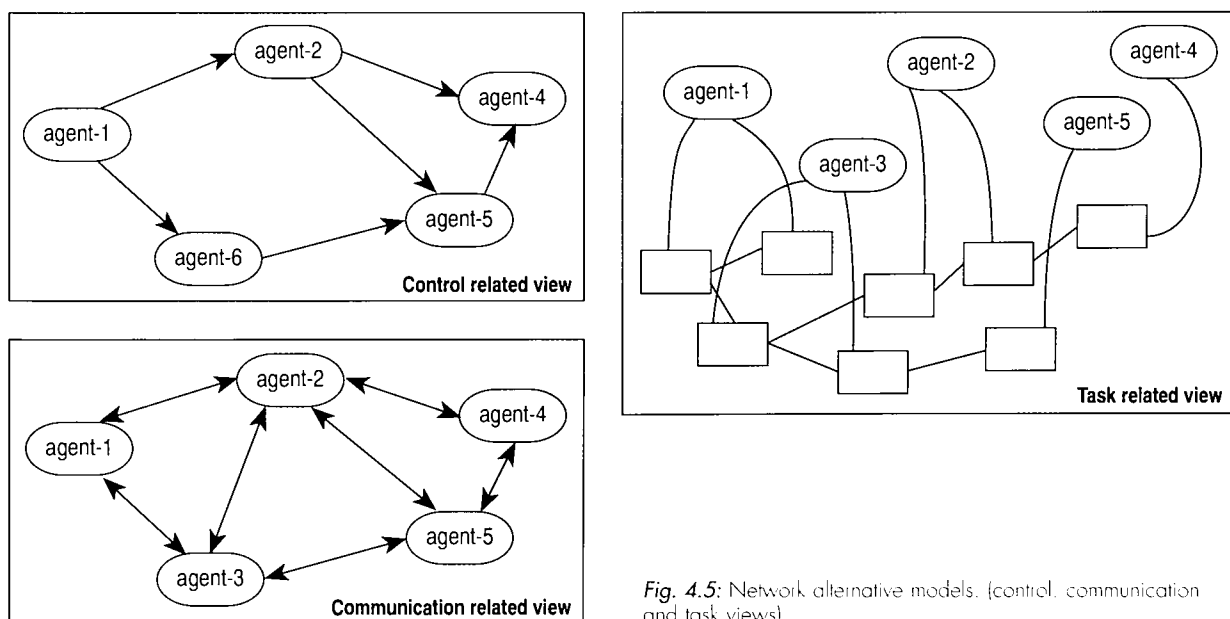

Control related view

Communication related view

Task related view

Fig. 4.5: Network alternative models. (control, communication and task views).

65

system and distributed debugging as described in /3/.

According to this design the main views of the system are based on: Agents presentation at various levels of detail, inter-agent interaction and communication visualisation, distributed domain level task view, inter-agent cooperation patterns, as shown in *Fig 4.5*. The developer, instructing the DA, can select the most adequate view of the system which maps to the developer's conceptual model. Distributed debugging presents great difficulties, since the lack of global time and the uncertainty of the system introduced by the network make it an impossible task to reproduce in real-time the distributed system operation. It is proved however that it is always possible to create a reconstruction of the distributed system operation built out of events collected at run-time which can be used for distributed debugging.

A preliminary example of DA architecture and its operation was demonstrated through the Iberdrola prototype. The Iberdrola agents where presented to the developer as graphical objects on the screen which can be browsed and abstracted at various levels. A demonstration of both aspects of the interface of ARCHON, i.e. the end-user (UIA) and the developer's (DA) in a distributed environment can be seen in *Fig. 4.6*. Finally consultancy work has been undertaken in the frame of the project in relation to the interface design of the multi-agent systems of CERN, Iberdrola of Spain and Electricity Council, U.K. see /1/. Also methodological aspects of design of user interface to multi-agent systems and the defini-

tion of a design framework have been established based on existing User Centred Design and User Task Analysis techniques.

The end-user and developer interfaces described have been prototyped in a distributed Unix X windows environment in Common Lisp in t he KBS laboratory and can be seen in *Fig. 4.6*.

CASE-Sup: Software Engineering Techniques for multi-agent systems

CASE-Support project studied applicability of standard software engineering techniques and knowledge based systems analysis and design methodologies for design and development of distributed intelligent systems. The purpose of this study was to introduce existing standards, techniques and tools in the development environment of DAI systems. The PCTE standard environment has been studied in this context. This environment has features like communication mechanisms, the distributed object repository and the modular user interface which facilitate construction of DAI development tools like the ones described in the previous section /6/. An experimentation involving definition of a methodological frame and a prototype development for a DAI system /8/ tested use of standard software design and development techniques. A result of this was that the fundamental differences between the development lifecycles of knowledge-based and information systems which are reflected in the programming environments used makes the use of standard computer aided software engineering (CASE) tools in this context a very difficult task which goes beyond the scope of this study.

Applications of DAI techniques: Technology transfer

In order to achieve technology transfer of the DAI techniques and tools developed, in the ISEI research process, an adequate application area was selected in which informatics systems based on these techniques can be useful. The area proposed is that of air pollution control in urban environments. The great amount of data involved in real-time monitoring networks and

Fig. 4.6: The UIA and DA for Iberdrola supervision and control system.

the multidisciplinary nature of the decisions to be taken, indicate that DAI techniques could be of particular interest. A feasibility study has been undertaken about applicability of ARCHON results in an air pollution episodes control system to be prototyped for the city of Athens, Greece. A more detailed study and design is expected to be performed in the frame of project ESCAPE (Experts and Systems for Control of Air Pollution Episodes) to be started in 1992.

E-CORDIS. Prototyping CORDIS Enhancements

CORDIS, Community Research and Development Information Service, is an initiative of the Commission of the European Community under the VALUE programme which has the objective to disseminate public information on and about all Community R&TD activities, for the purpose of enhancing awareness on these activities, assist interactions and cooperation among individual programmes and their participants, and help promote coordination with similar R&TD activities in Member States. It is coordinated by the Directorate C of the Directorate-General for Telecommunications, Information, Industries and Innovation.

CORDIS provides information stored in nine data bases which include information on Programmes under preparation, description of Programmes, key references, internal contacts, etc; description of projects and the participating organisations, abstracts of documents and technical reports resulting from projects, information contacts within Member states, expressions of partnership interest, descriptions of results and R&D prototypes, news and announcements (like Call for Proposals), etc. This information arrives to CORDIS from other DGs of the Commission, like those of Agriculture, Transport, Environment, Scientific Research and Development, Information Technologies and Telecommunications, Fisheries, Regional Development, Energy and Education and Training. At present, CORDIS can be accessed via the ECHO (European Commission Host Organisation) Computer Services Hosts in Luxembourg.

While the information set is quite extensive and properly focused on the targeted market, mainly SMEs which intend to perform a first level information search, the access facilities are restricted by both availability of network connections and limited functionality of the user interface.

In recent years, the ISEI has been engaged in the development of new concepts and tools for the management of information. In particular, a number of research actions in the field of multimedia systems and full text document services are in progress in the AAITCE division of the Institute for Systems Engineering and Informatics. E-CORDIS is a collaboration agreement between DG XIII and the ISEI which has as the main objectives to augment the information distributed by electronic media, to explore other media of data publishing and distribution (CD-ROM, magnetic/optical) and to increase the usability of the information by means of enhanced user interfaces. The main results of the collaboration action between the ISEI and DG XIII are the following:

E-CORDIS ONLINE

The present user interface to the CORDIS service is command and menu driven, thought, mainly, for dial-up connections from dumb terminals. Today, however, many users have personal computers with reasonable graphic capabilities available. In order to improve the usability of the CORDIS service, an enhanced form-based user interface has been produced. This user interface traps the stream resulting from the online connection to the CORDIS databases and presents commands and data in a comprehensive way to the user. The user is able to compose complex queries by clicking on the options presented to him and by compiling labelled fields. Furthermore, a pop-up help message appears just by setting the cursor on a particular item of those composing the form. Cut and pasting functionalities are also provided to the user, who, in this way, may further exploit the information arising from his queries. At present, this user interface is available on Macintoshes and it is planned to be ported to the Windows 3 environment during 1992.

E-CORDIS CD-ROM

At present, ECHO hosts are accessible through dial-up lines and International Packet Switched Data Networks. Previously to the developments in the E-CORDIS ONLINE project, no graphical capabilities were available in the user interface of CORDIS. The restricted and expensive availability of network connections and the limited functionalities of the user interface suggested that one of the results to be obtained from the collaboration between DG XIII and the ISEI was the production of a pilot CD-ROM of CORDIS. This CD-ROM has been produced and includes all data stored in the CORDIS databases. Periodical updates of the contents of the CD-ROM are foreseen.

It also provides a complete and friendly user interface and a context-dependent help system.

E-CORDIS HELP

The user does not always have the several manuals corresponding to the different CORDIS data bases available. This makes the navigation through the hierarchical structure of the data bases quite difficult and expensive, particularly if this search is taking place though a dial-up connection. In order to ease access to the CORDIS service, an online help system has been developed. This system compiles all the help documentation related to the CORDIS online query system. It is resident locally and may be made available to users in client/server mode through a local area network, PSDN or leased lines.

SUPER LIBRARY

Together with the user interface and the distribution media, one of the main goals of the collaboration between DG XIII and the ISEI was to augment, both in range and quantity, the information provided through the CORDIS service. At present, just reference-based data is provided to the user, who, once he has identified the relevant items, has to contact a different source of information, generally a publishing service, to get the object of his search. The milestone of Super library is the creation of a computer network to collect, manage and disseminate the full text results of all public Research and Technical Development carried out in the Community, the so-called Virtual Library. To achieve this, the new technologies of computing and telecommunications will be employed.

Two are the lines followed at present in order to implement the Virtual Library. On the one hand, a system thought as a Windows 3 application will focus on the intuitive representation of the library, and by means of Virtual Reality mechanisms, will concentrate to reproduce the cognitive representation of both the library and the book metaphors.

On the other hand a prototype of an Electronic Document System has been developed. It provides full text electronic document access and retrieval as well as integrated messages and formatted document interchange services. It has been targeted to the X environment and designed according to the client server architecture. The system is composed of a set of cataloguing tools which allow catalogue creation and maintenance and aliases definitions; document access tools which allow to filter the document data base by author, matter, keyword, etc, by matching

expression on the title of the full content of the document, and to navigate among documents through references and aliases; and document retrieval tools which allow access to the document data base either through dial-up and X.25 lines or through ethernet local area networks and facilitate document edition printing and mailing. In the line with these concepts, a project proposal called VEL which has the objective of interconnecting the document databases of three European libraries has been presented to the Libraries area of the Telematics Systems in Areas of General Interest Programme.

References

/1/ HALL, L. - The unbearable lightness of being a control engineer in the electricity supply industry, User task analysis of CIDIM application, JRC/Archon - Technical Note 009/2-91, Ispra, February 1991 (1991)

/2/ AVOURIS, N., LEKKAS, G. - "Cooperating Expert Systems: experience and perspectives", Proceedings of the 3rd Panhellenic Conference in Informatics, vol I, pp. 503-517, Athens, June 1991. (in Greek) (1991)

/3/ VAN LIEDEKERKE, M., AVOURIS, N., LEKKAS, G. - "Revised Specifications of the User Interface to the Archon abstract machine", ARC HON Del 440-27, Ispra, June 1991 (1991)

/4/ AVOURIS, N., HALL, L., OLIVEIRA, E., MUTA, F. - Human Computer Interaction in ARCHON, Chapter 5 of ARCHON130-30 Public Deliverable, to be published as: T Wittigh (ed), ARCHON: An architecture for Multi-agent systems, Ellis Horwood (publ), 1992 (1991a)

/5/ AVOURIS, N., VAN LIEDEKERKE, M., HALL, L. - User Interface design for cooperating agents in industrial process supervision and control applications, Ispra October 1991, submitted for publication to IJMMS (1991c)

/6/ AVOURIS, N., VAN LIEDEKERKE, M. - Advanced Software Engineering Tools for Development of Distributed Intelligent Systems, Reports I and II, Ispra (1991)

/7/ AVOURIS, N., FINOTTI, S. - User Interface Design for Expert Systems based on Hierarchical Spatial Representations, Ispra, November 1991, submitted for publication to ESwAppl. (1991)

/8/ LEKKAS, G., VAN LIEDEKERKE, M. - PROTOTYPING MULTI-AGENT SYSTEMS: A CASE STUDY, to be included as a Chapter in N. Avouris, L. Gasser (ed), Distributed Artificial Intelligence Theory and Praxis, Publ. by Kluwer (forthcoming) (1991)

/9/ HALL, L., AVOURIS, N. - Transparency of the User Interface to a DAI system, to be included as a Chapter in N. Avouris, L. Gasser (ed), Distributed Artificial Intelligence Theory and Praxis, Publ by Kluwer (forthcoming) (1991)

/10/ MEYLEMANS, P., SPINELLI, A. (Bull Italy), MEBKHOUT, A. - (IIRIAM), The KWICK System Architecture, Kwick Deliverable: KWICK/SAT/ARC/000 3, Version 1.0, June 1991.

/11/ BENETTI-GENOLINI, F., (Tecograf Software SRL), MEYLEMANS, P., SORESI, F. (Bull Italy), The KWICK User Interface, Kwick Deliverable: K WICK/UIT/UI:/0001, Version 1.0, June, 1991

/12/ Mekhout, A. (IIRIAM), MEYLEMANS, P., SORESI, F. (Bull Italy), SPINELLI, A. (Bull Italy) - The KWICK Implementation Architecture, Kwick Deliverable: KWICK/SA&UIT/IAR:0002 - Version 1.0, June, 1991.

/13/ MEYLEMANS, P. - An Architecture for Control and Communications in Distributed Artificial Intelligence Systems, KWICK Technical Note: KWICK/JRC/TN/0006 - Version 1.0, May, 1991 (1991a)

/14/ MEYLEMANS, P., RANA, A. (JRC) - The Application of an Enhanced Distributed Problem Solving Architecture for Advanced Office Automation, KWICK - Technical Note: KWICK/JRC/TN - DRAFT, 1991

Parallel Computing Applications

To contribute to the valorisation of ESPRIT results with particular reference to the SUPERNODE computers (ESPRIT Basic Research), it was decided to create a critical research and reference point for advanced computing including the introduction of parallel computing into the ISEI specific application domains. A multiannual inter-DG agreement has been initiated. Furthermore an inter-Institutes IRSA-ISEI agreement has been pursued within the framework of the Agriculture Project using the NOAA Satellite results.

The following tasks have been accomplished:

In collaboration with other CEC Programmes, especially with the VALUE Programme, new theoretical developments have been done on Image Processing and Synthesis and in particular many enhancements of the 3D Image Ray-tracing and radiosity software have been achieved and the extension to the animation aspects in real-time have been performed.

The implementation of this complex software has been done on the SUPERNODE T.NODE 64 Transputer Parallel Machine.

Results obtained on T-64 NODE proved that the efficiency is nearly identical to a CRAY YMP-2 (500 MIPS and 250 MFLOPS).

As regards the Agriculture Project, within the framework of the inter-Institutes collaboration, a special effort has been dedicated to the SPACE software. The objective of this system is to visualise NOAA satellite images on high resolution peripherical devices and to perform all the necessary corrections of these raw data in order to be used by end users, specially for agriculture interpretation and/or global change research studies.

The implementation of the complete SPACE software

has been done on dedicated working stations using a standard UNIX system V and X-WINDOW release 11.4. This work has been developed in such a way that facilities have been included for using internal and external LAN.

Important work has been done in order to parallelise this SPACE software and the first parallel implementation has been initiated. The present results have been demonstrated on Transputer SUPERNODE Parallel Machines during the "SUPERCOMPUTING MEETING Europe 1992" held in Paris.

Data structuration by octree and KD-tree technique for multiple functionalities development

Within the framework of a collaboration between TELMAT Informatique and ISEI, the implementation of this hierarchical coding technique has been pursued. The optimisation of the visualisation technique has been achieved on the SUPERNODE T.NODE 64. The main functionalities demonstrated that fast data storage and retrieving, accurate 3D Image visualisation with realistic shading, octree reconstruction and manipulation can be achieved with efficient shading.

References

/1/ GROSSETIE, J.C., GASSILOUD, D. - Computing with Parallel Architectures: T.NODE Kluwer Academic Publishers ISBN 0-7923-1225-2. Computer & Information Science Vol.2 (1990)

/2/ GROSSETIE, J.C., HEIDRICH, D. - Computing with T.NODE Parallel Architecture. Kluwer Academic Publishers ISBN 0-7923-1483-2 Computer & Information Science Vol. 3 (1991)

Secretariat Support to COST Activities

The work consists of the secretariat and the related activities for:

• the COST Technical Committee for Telecommunications (TCT) and

• the COST project 211ter.

Activity related to TCT

Three meetings were held by TCT in 1991: Berlin, 5-6 March 1991; Stockholm, 11-13 June 1991; Rome, 17-18 October 1991.

The secretariat work implies the preparation and attendance at the TCT meetings and several other meetings, in particular the COST Senior Officials meetings, the preparation of reports and classifications, the preparation of Memoranda of Understanding (MOU) in three languages for new projects, preparation of workshops for the formulation of new proposals, etc.

Activity related to project COST 211ter

The secretariat for this new project on "Redundancy Reduction Techniques for Coding of Video Signals in Multimedia Services" continued the activity of the previous years. The new scenario caused by ATM (Asynchronous Transfer Mode) imposed modifications in the conception of coding. The project results will contribute to the creation of new specifications by the standardisation bodies. Two meetings were held in 1991: Brussels, 29-30 January 1991 and Oslo 26-27 June 1991.

Valorisation

Multipurpose On-site Readable Ultrasonic Seals

A preindustrial production of ISEI developed "Low Cost" multipurpose seals to be read on-site with an ultrasonic equipment has been provided by the French company ELCA and tested and followed by our laboratory. A second production has been launched in order to test the unicity of all ultrasonic signatures among a same batch. The reading equipment has been defined and ordered. A study has been started to improve the seal without changing its principle by replacing its stainless steel loop by a fibre optic loop (Multipurpose On-site Verifiable /Ultrasonic Seals).

Topography Keys

Based on a ISEI development and patent, instruments using the measurement of "surface signatures" of metallic keys to open or trigger doors or access controls have been manufactured by the French company SPECTEC. The development involves building the lock units and mechanical parts along with developing a dedicated processor and software for the acquisition and comparison of the surface signatures. Two complete sets of equipment will be installed in the laboratory in Ispra.

VALUE Programme 3D Image Processing

Image and holographic processing and synthesis

The Image Processing and Synthesis techniques are applied to the synthesis of holograms in such a way that one can reconstruct real three dimensional scenes. The developments are based on optical phenomena that were discovered in the ISEI 3-D Image Processing Laboratory. The main objectives of the work is to develop a mathematical package to simulate this discovery and thus realise an industrial European prototype for image compaction and 3-D restitution on advanced parallel computers.

The following tasks have been accomplished:

- New theoretical developments on basic Ray tracing and radiosity techniques have been undertaken.

- A complete new image synthesis software has been implemented on parallel SUPERNODE T-NODE computers in the ISEI 3-D Image Processing Laboratory.

- Concerning the holographic synthesis, experimental results obtained on the LASER optical set-up demonstrated not only the feasibility of the volume holographic synthesis project but emphasised that one is able to synthesise real volume holograms. Theoretical developments are now achieved, and the implementation on SUPERNODE T.NODE 64 parallel machine has been initiated.

- Mathematical hologram synthesis has to use a set of basic numerical tools, based on the fast transform principle, five kinds of transformations have been studied and implemented on working stations and on SUPERNODE T.NODE parallel computers. Thus FOURIER, HADAMARD, WALSCH, PALEY and HAAR's transformations and WAVELET techniques constitute an advanced software package. The applications of such a package are needed by many research domains, especially for standard image compaction techniques and holographic techniques applied to robotics, medical images, remote sensing images and in space sciences in general /2/.

- In particular the application of the fast transform package has been extensively used to study the performance of a new holographic technique relying on the spatial correlation of laser-speckle

intensity measurements. These developments have been recently proposed for explaining and synthesising multi-speckle-holograms (phenomena discovered in the laboratory) of coherently illuminated objects. This important step has been demonstrated in our laboratory using an iterative fast-transform phase retrieval algorithm /1/.

References

/1/ GROSSETIE, J.C., FRANCHI, M. - Procédé d'Enregistrement et de Restitution Visuelles d'une Scéne Tridimensionnelle (Multi-Speckle-Holograms Phenomena) European Patent Number 87 606

/2/ GROSSETIE, J.C., CHECCHI, E. - Diffusely Reflecting Radiosity Technique in Image Synthesis EUR 13381 EN (1991)

VALUE Programme
Transfer of Solar Technology

The ISEI continued its support to the VALUE programme of the Directorate General for Telecommunications, Information Industries and Innovation (DG XIII). Activity concerned the transfer of technology in the solar thermal sector, specifically, the transfer of Ispra expertise in the use of low-level tele-monitoring to provide a "solar systems thermal performance guarantee". This was applied to 8 hotels in Greece and the first results are now available. A great deal of interest has been shown in the concept, particularly by the local Solar Industry Association.

In 1991, an activity has been initiated, to transfer calibration technology developed at ESTI to the Spanish research organisation CIEMAT. This technology will be applied to photovoltaic industrial products and will consist in a precision calibration facility with necessary hard - and software, located in Almeria, the largest operating solar poser site in Europe.

SUPPORT TO THE COMMUNITY ENERGY POLICY

Scientific Technical Support to EURATOM Safeguards

ISEI is providing an extensive technical support programme to EURATOM Safeguards Directorate, which is defined in 40 specific tasks. Several institutes are involved in this programme: CBNM, ITU and EI are performing chemical analysis of samples taken by inspectors in nuclear facilities and are developing analytical techniques and preparing reference materials. IST is providing support in the field of non destructive assay techniques as well as calibration and training facilities. Consultancy on matters related to radiological and conventional safety is provided by JRC specialised services and health physics training courses are organised regularly for inspectors. ISEI's activities concentrate on the following areas:

- Nuclear Materials Accountancy and Data Management
- Surveillance Techniques
- Sealing and Identification Techniques

Implementation of Extended MADES in a distributed processing system

The new MADES (Material Accounting Data Evaluation System) version installed at ESD (Luxembourg) is primarily a conversion into the NATURAL-2 fourth generation environment and the system is now in routine production operation. In addition this version allows more user-friendly features, such as the use of function keys and windows, and is more powerful in the variance calculation due to the floating point facilities. The new requirements concerning the parallel batch runs for element and isotope data has been installed and tested. The next step for the task deals mainly with the introduction of new stratification parameters (such as batch name), the possibility to add and store comments on stratification or variance calculation, and the management of final results.

Implementation of Inspection MADES

During this period of time the main activity was to design and implement the new features to allow the

system to include the the D-Statistic evaluation, and the inventory estimate corrected by D. The statistic model that was applied to the system is the same model utilised for the PIV Exercise course. The intention is to proceed with the implementation of D-Statistic for the entire material balance, as the previous model takes only into account the end inventory period, using both the operators and inspectors measurement system. There are some other aspects of the system that are to be defined, in particular the way in which the inspection data have to be provided to the system. The expectation is to complete the system, as soon as the inspection data becomes available.

Video Surveillance Techniques

The main requirements of surveillance systems are the reliability in long term unattended operation and the capability of reviewing a high amount of data recorded as pictures. ISEI developed several modular and integrated systems for recording such surveillance data. Similar techniques can also be applied to the verification of seal pictures.

Computer aided video surveillance

In the field of multicamera recording systems a new generation of integrated and computer controlled surveillance system (CAVIS-2) has been developed and installed at DCS headquarter /1/2/. It provides the full remote control of all connected video units by the computer. The system configuration as well as the recording parameters of multiple video channels are programmable. Error detection capability allows a high reliability in unattended operation. The user interface respects all the specifications requested by the Euratom authorities; it helps and guides the inspectors through the whole verification procedure.

Computer aided review

A first review station (CARES) has been developed for reviewing at headquarter the video tapes recorded by the CAVIS-2 systems (Fig. 4.7). The realisation and test in laboratory are under way. A more generic review station is planned in the future for reviewing tapes recorded by different recording systems which are presently not compatible. In order to allow an easy search and examination of single pictures, a digital frame buffer will be included in the system. The modular design of this review station foresees the integration of the polyline method for detecting scene changes. A digital storage medium
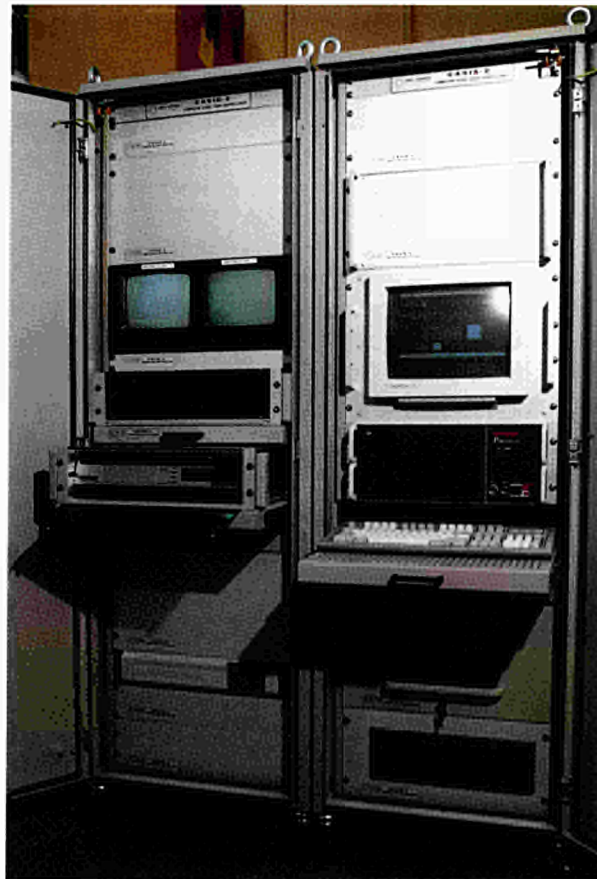

Fig. 4.7: Front view of CAVIS-2 system Computer aided review.

for dumping the selected images will substitute the video recorder.

Data base of video systems/components

In order to allow an efficient management of the DCS video systems and components in the different plants in Europe the software ASCOR (Automatic Systems and Components Organisation) has been developed /3/. It is composed of seven databases concerning types of components and systems, locations, history, system configuration and operation book. The first version was installed in June the second in September 1991.

Pattern recognition in seal images

The method implemented in the automatic verification systems of E-metal seals /4/ has been investigated for application on fibre optic seals. It consisted in dividing the seal picture in 64 subareas in which filtering and successive correlation with the correspon-

dent reference area were applied. The aim is the detection of small variations in the picture. Laboratory tests have shown that this method requires a precise mechanical positioning of the fibre optic seal.

Sealing Identification Techniques

ISEI has developed in the past an ultrasonic identifiable seal in the form of a bolt to be applied on the so-called "Multi Element Bottles" (MEB), containing LWR spent fuel elements. A large number of these MEB's are stored in spent fuel storage ponds at the BNFL plant in Sellafield. These seals and technique of identification have gone through many feasibility tests on site in the past four years. In 1990 the EURATOM Safeguards Directorate indicated a definite interest for that method and an extensive field test could be organised in 1991 for the sealing of 50 MEBs in real conditions. Up to eleven sealing campaigns were conducted in Sellafield transfer and storage bays, during which 50 sealing bolts of the MK4r type (designed, assembled and checked at Ispra) were installed, verified and some reverified and removed. The verification instruments and software (users manual) were tested in the presence, or by EURATOM and IAEA inspectors along with the underwater tooling designed and manufactured by ISEI.

Identifier for Magnox Reactor Deadweight (IMARED)

Further to the safeguarding of Multi Element Bottles (mentioned above), sealing bolts may be used for the verification of other items such as underwater Reference Dead Weight Skips used to calibrate Weighbridge in the storage bay of MAGNOX reactors. On request from EURATOM Safeguards Directorate the feasibility tests carried out in 1990 at the Sizewell Reactor (UK) have been followed by the study and preparation of ad hoc tooling, suitable for use in deeper ponds. This should be tested after the sealing bolt field test in Sellafield (see above) will be concluded.

References

/1/ BETTENDROFFER, E., MOL, M., COLZANI, S. - "CAVIS-2 Computer Aided Video Surveillance System, user manual" - Technical Note I.91.90, July 1991

/2/ MOL, M.J. - "CAVIS-2 Software reference manual vol. 1 - Technical Note I.91.91/1, July 1991

/3/ MORANDI, C., DEL RE, F. - "Automatic Systems and Components Organisation, users guide", Lancaster's technical manual, June 1991

/4/ SOREL, F. - "Computer applications in optical surveillance", Esarda Bulletin, July 1990

Solar Energy and Energy Conservation

THERMIE

Under an agreement between the ISEI and the Directorate General for Energy (DG XVII), the ISEI carries out detailed assessments of proposals presented to the Commission for the award of THERMIE support grants, in a number of fields. These fields are solar energy - (thermal and photovoltaic), energy conservation in buildings, and transport. The Commission wishes to ensure that THERMIE proposals are not supported unless they show good prospects for economic viability and future replication. Particular effort is, therefore, put into estimating these aspects. Extracting the necessary information from the proposals is not, however, always easy.

In the course of 1991, a total of 117 proposals was assessed in the buildings sector (61 for 1991 and 56 for 1992), 69 in the transport sector (37 for 1991 and 32 for 1992), 65 in the solar thermal sector (30 for 1991 and 35 for 1992) and 62 in the PV sector (30 for 1991 and 32 for 1992). In addition to the appraisal of new proposals, the NNE follows the technical progress of current THERMIE contracts, through the analysis of reports and selected site visits and updates the SESAME data base.

Special attention has been paid to the development of guidelines for the technical follow up of solar thermal plants and, to enhance progress, the NNE has set up a European working group on the topic. The guidelines aim to help contractors to fulfill the contractual obligation to provide the Commission with technical information. This information, whether very specific or only partial, is collated with data from similar projects and is a fundamental contribution to any further action of the Commission. Another aspect of this activity concerns a proposal for the economic evaluation of solar systems through the "Life Cycle Cost Analysis" approach. It involves the comparison of two alternative energy systems (solar and conventional) with the same final objective. Emphasis has also been given to the concept of tele-monitoring for solar systems, for which a prototype data acquisition system and data base was set up. This approach is important for the checking and evaluation of THERMIE projects.

Monitoring of PV Demonstration Projects

The objective of this activity is to provide technical assistance to contract management and project performance evaluation in the PV part of THERMIE (European Technologies for Energy Management), which is the follow up programme (1990-1994) of the DG XVII Energy Demonstration Programme (1979-1989). The cooperation with DG XVII started in 1983 with the participation in the selection of the PV Demonstration Projects and the preparation of guidelines for the monitoring of PV plants, i.e. for the acquisition, transfer and evaluation of operational data. Actual monitoring of the PV projects initiated at the end of 1985; so far more than 500 "station-months" of data have been collected, analysed and stored. During the last years (1989-1991) support reached the constant level of 5 man-years. The importance of plant monitoring is already recognised explicitly in the "call for tender" for THERMIE projects: "The monitoring programme of the photovoltaic installations of a total duration of two years must be carried out in conformity with the "Guidelines for photovoltaic system monitoring" of November 1987. These guidelines were prepared in cooperation with an expert group and are obtainable on request to the Commission of the European Communities, Directorate-General for Energy, Brussels".

The "Guidelines for the Assessment of PV Plants" have been developed by ESTI in open discussion with an expert group (European Working Group for PV Plant Monitoring) coordinated by ISEI, and are continuously updated since its first edition in 1986. They are part of the contract between DG XVII and the operators of the PV demonstration project. The 1991 meeting of the European Working Group on PV Plant Monitoring was organised in Berlin, and both Documents A and B of the "Guidelines" concerning "Photovoltaic System Monitoring" and "Analysis and Presentation of Monitoring Data" were updated and newly issued. During 1991 monitoring data from more than 20 projects have been analysed and presented in about 160 monthly and 25 intermediate and final performance reports. The data are stored on line on the HP 9000/370 computer of ESTI in the largest existing data base on PV operational data. They are accessible via the European computer network to all authorised persons for research purposes. ESTI has hosted the 1991 contractors meeting at which participated more than 40 PV plant managers, together with representatives of the European PV industry and with the coordinators from DG XVII.

Another significant contribution to the DG XVII PV programme consists in the evaluation of the technical part of new proposals for PV projects, the analysis of the progress reports and the corresponding updating of the PV part of the SESAME data bank.

New data acquisition equipment is under test in the ESTI laboratory, including satellite-based telemonitoring systems and recommendations on its suitability for field use is provided to the contractors.

The highlights of these activities in the field of PV plant monitoring were presented at the 10th E.C. Photovoltaic Solar Energy Conference in Lisbon.

Also during this year two on-site measurements at the 100 kW plant of the isle of Tabarca (Alicante/Spain) and at the 10 kW plant at Los Arcos (Murcia/Spain) were performed, using the capacitor-type dynamic load for the determination of the current-voltage characteristics of the arrays. The aim of these measurements was to verify that the contractual conditions concerning the installed nominal power of the plants have been met.

Climate Indicator

At the request of DG XVII, a study has been made /1/ of the degree-day indicator published in the EUROSTAT Energy Statistics. This indicator is intended to give readers a means of allowing for severity of climate when comparing energy consumption between countries or from one year to another. DG XVII suspected, however, that the figures were not really representative of the climate actually experienced by the population as a whole. The method currently used by EUROSTAT to derive the degree-day (DD) figure was, therefore, analysed in detail and suggestions made for its improvement.

The first objection to the current method is that it counts the DDs in a heating season, the length of which is assumed to be equal for all locations in the Community. To determine the error introduced by this assumption, a simple physical model of a building was used, together with Test Reference Year meteorological data, to establish the true lengths of the heating season in a number of cities. The method defined the heating season as the period during which heat losses through an east or west facing, partially glazed facade are greater than the gains. This showed that the EUROSTAT heating season, while acceptable for northern locations is far too long for southern ones. One recommendation of the study was, therefore, to use the DDs for the whole year, rather than for the heating season alone.

A second objection is the choice of the meteorological stations from which the national averages are made. These are unsatisfactory because some obvious climatic zones are totally unrepresented, whilst others contain more than one station. An even more serious objection is that the regional DDs are not weighted by population in the national averages.

The study, therefore, identified climatic zones for each member state, based either on the official zones or on analyses of topography and DDs. The met-station chosen to represent a zone was the one whose DD value lay closest to the average for the zone. The estimation of population was complicated by the fact that the climatic zone boundaries seldom coincided with those of the administrative zones.

The final result was a set of met-stations, which more truly represent the climates of each Member State, together with weighting factors based on the population of each climatic zone.

Environmental Costs of Electricity Production

The production of electricity creates environmental insults whose costs are not fully reflected in the prices paid by consumers for electricity services. Failure to incorporate these external costs leads to economically inefficient production and consumption decisions. In a first approach to this topic, a review was undertaken of two related efforts to address this market distortion. The first concerns progress in estimating the uniinternalised environmental costs of electricity production. The second concerns market-based approaches to internalising these costs in electricity production and consumption decisions. The results of this study were published /2/3/4/.

The review began by describing an integrated framework to identify the source of particular environmental insults as well as to identify points along the pathway from insult to damage where environmental policies can intervene.

In applying this framework to the environmental externalities from electricity production, it identified three general approaches to measuring the cost of these externalities. Indirect methods are used to measure the value of goods not traded in formal markets, such as human life, scenic, and recreational goods. Direct methods are used to measure goods for which economic costs can be readily assessed, such as the value of lost agricultural products, or the cost of repairing damaged goods. Methodological issues and data limitations complicate application of both approaches. When these problems are significant, proxy methods are used to measure the costs of avoiding the initiating insult rather than the cost of the damage created by the insult.
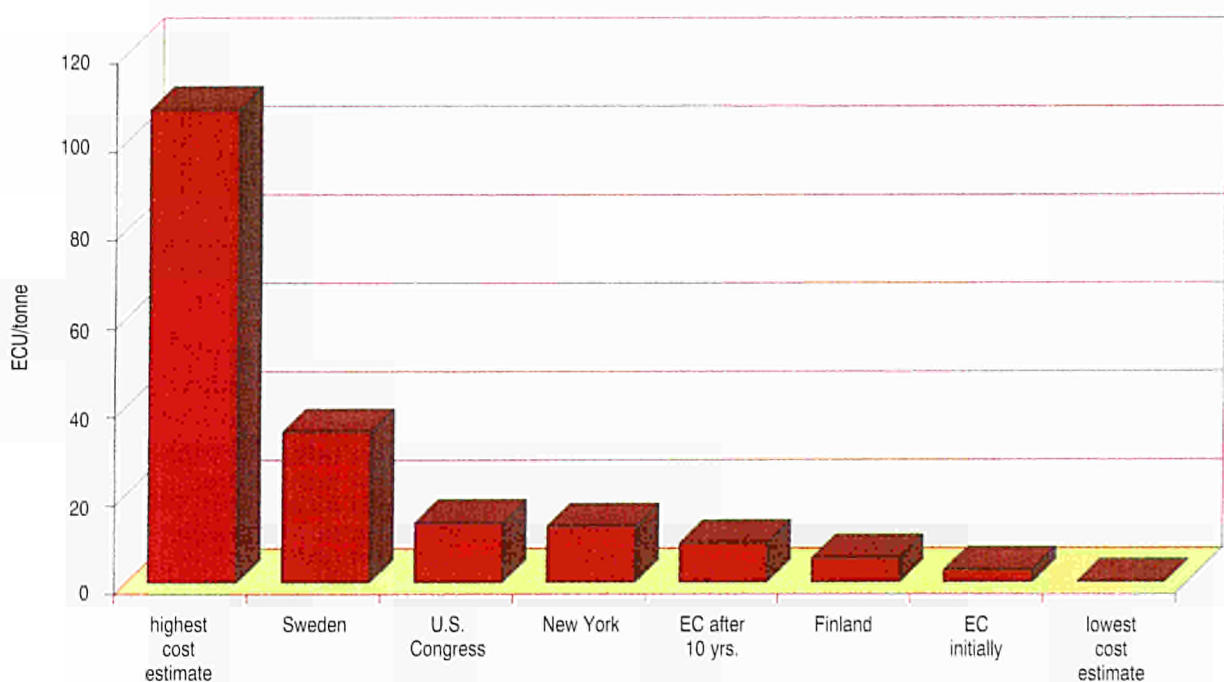

Fig. 4.8: Environmental Externality Charges proposed for CO_2.

It was found that significant progress has been made in quantifying selected damages. These include, damage to health, agriculture, materials, and visibility, from emissions of SO_2, NO_x, and particles, routine and accidental radiation releases from nuclear powerplants (both during operation and decommissioning), and fabrication and operation of wind and solar photovoltaic electricity generators. Nevertheless, many other, potentially significant, aspects of certain fuel cycles remain unanalysed. Individually or when combined for a particular generating technology, it was found that the estimates of the external environmental costs of electricity production can exceed the current price of electricity in a country such as the USA and, if included, would greatly increase it. This finding suggests that there is a large difference between the costs borne by private producers and consumers of electricity and the costs that these activities impose on society.

The study also identified important limitations of existing estimates by analysing a recent major study /5/ of environmental (and other) externality costs in greater detail. In addition to identifying relatively straightforward limitations of the methodology and data used, it raises important considerations for the use of quantitative information in measuring environmental costs. The net impact of these considerations is that current estimates of the environmental externality costs of electricity production are probably low.

The review of environmental externality costs was followed by a survey of market-based approaches to internalising them. Market-based approaches differ from regulatory approaches in that they allow the polluter greater discretion in compliance. Whilst regulatory approaches typically mandate specific actions with little consideration of the cost of compliance (e.g., installation of best-available control technology on a plant that will be retired before the end of the useful life of the pollution control equipment), market-based approaches provide some flexibility in response. Two market-based approaches are relevant to internalising the external environmental costs of electricity production. The first is charges in which pollution fees or taxes are assessed, based on the quantity of a given insult created by a polluter. Charges allow the polluter to choose between investment in pollution control or payment of the charge. The second is market-creation in which a fixed number of permits to pollute are issued and then sold, traded, or leased by polluters, among themselves.

Market-creation allows polluters to purchase abatement equipment (and sell their excess permits) or purchase permits from others. With charges, the value of the individual environmental externalities are determined administratively. With market-creation, these values are determined implicitly through the operation of the market.

This survey confirmed the relative newness of market-based approaches as instruments of environmental policy. Charges exist or are under discussion for SO_2 (France, Denmark, Sweden), NO_x (Sweden), and CO_2 (Denmark, Sweden, Finland) emissions (Fig. 4.8). Of these, the proposed charges for Sweden are considerably higher than those of France, Denmark, and Finland. In the United States, charges are rarely used to change the cost of electricity generating resources to the consumer, but they are being used in evaluations of the appropriate choice of future generating resources or conservation. Existing market-creation activities are limited to the U.S. for areas that have not yet met federal clean air standards. A market-creation policy for acid rain precursors was expected to be in place in the U.S. before the end of the 1990ties.

The study compared the estimates of environmental externalities with available pollution charges (since there are no comparable values available from market-creation activities) to provide some perspective on the levels of charges. While there seems to be reasonable comparability between the charges and the damages they seek to internalise (especially, the proposed Swedish charges), it was observed that the comparison is imperfect. It was known from the start that the estimates of externality costs are probably low. In addition, there are often other influences on the price of energy, which reinforce or diminish the effects of charges that incorporate the costs of environmental damages. For both reasons, direct comparisons should be viewed with caution. An additional comparison of charges with the costs of abatement, highlights the apparent cost-effectiveness of abatement relative to most charges.

The comparison also raises a concern over the equity of such charges, which is this. While the use of charges to internalise environmental externalities may increase the economic efficiency of electricity markets, they could be considered unjust, in that the charges proposed do not seem to be intended for use in mitigating the environmental damage that is the basis for their imposition. A way of ensuring greater equity

would be for governments to render charges, at least in part, tax neutral. In this way industry would not be penalised, with respect to foreign competitors but, by investment in abatement technology, could even gain an advantage.

The use of economic principles to guide environmental policies is a relatively new phenomenon. There are good reasons for believing that their use will lead society to attain its environmental quality objectives in a cost-effective manner. However, in the absence of economic quantities for many of the values that society holds dear, cost-effectiveness may be only a secondary consideration. Governments should not rely solely on monetary estimates of the value of environmental externalities to guide environmental policies (if only because we know these estimates to be imperfect). Similarly, exclusive reliance on market-based approaches to internalise these costs will only yield efficiency benefits, if the markets themselves are workably competitive.

Management/Expert System for the Energy Auditing of Buildings

In a seminal study /6/ a benchmark comparison of commercial energy auditing methods was conducted. Four companies, from three countries, were asked to carry out audits of the same set of buildings: - a primary school, six apartment buildings with a common heating plant, and a single family terraced house. In addition, the buildings were subjected to a very detailed survey, in order to be able to judge the accuracy of the commercial audits. This study found little agreement between the recommendations of the commercial audits and no correlation between the cost of an audit and its accuracy.

The wide dispersion observed in the data collected and the general lack of agreement on recommendations, showed a need for more rigorous training of auditors and the development of standard methodologies linked to European, rather than national, norms and standards. (This need is all the more signi-
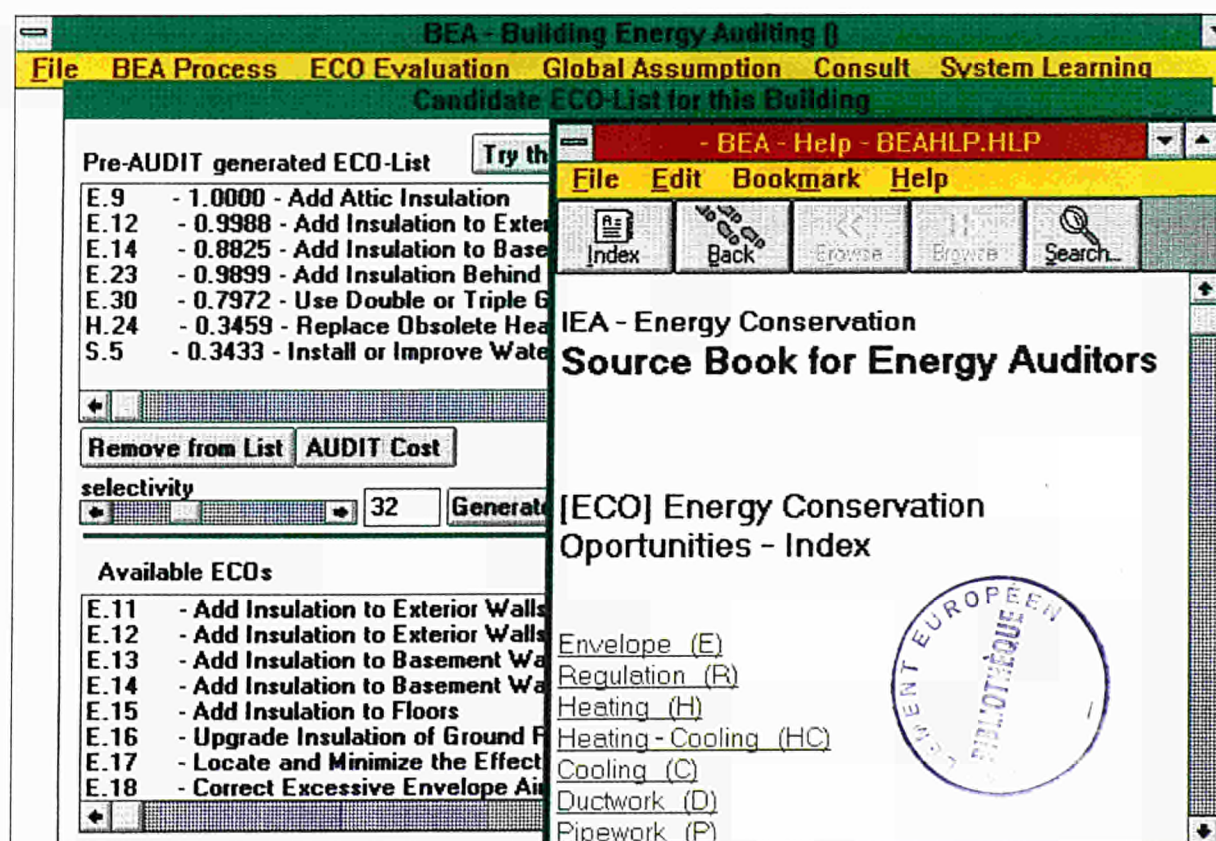

Fig. 4.9: Computer Display of Windows of BEAMES Expert System.

ficant if the objectives of the European Single Market are to be achieved in the important field of energy conservation in buildings.) It is not surprising, however, that auditors make mistakes. One has only to consider the number of different building categories, types of heating and cooling systems, fuel types, possible energy conservation measures (200-300), many of them interdependent, and the norms, standards, rules and regulations, to be borne in mind, to realise the difficulties they face. Such knowledge cannot be acquired quickly, yet, with growing concern for the environmental damage caused by excessive energy use, there is a need for many more highly trained auditors. In this area an expert system could be of great benefit and ISEI is now developing a Building Energy Auditing Management/Expert System (BEAMES) *(Fig. 4.9)*. This is intended to provide a major advance in auditing technique, which will have two uses:

- as a training tool for personnel
- as a field-guide for energy auditors.

This system has been designed to run on PCs, under the Windows environment, in either a user determined or system guided sequence. In practice, a user can follow any preferred sequence and then use the system to prompt for forgotten items. The choice of the Windows environment makes BEAMES easy to use and particular attention has been given to the provision of a user-friendly interface. Once sufficient data has been inserted, the rule-based system is able to advise on the action to be taken, if any, to reduce energy consumption. The expert system makes use of a small data base of retrofitted buildings, subdivided into several categories and types. The most suitable set of measures for the building under examination is determined by means of a neural network, which links the building with the most successful measures

proven for that type of building. The recommended measures can be ranked according to cost-effectiveness. Budget limitations have, so far, restricted BEAMES, to the auditing of relatively small, residential buildings. There is no technical barrier, however, to its eventual expansion to larger and more complex buildings, provided finance is available.

In its present form, the expert knowledge base has been derived from the Source Book for Energy Auditors produced by the IEA's Annex 11 Energy Conservation in Buildings and Community Systems, in which the ISEI was an active participant. Its future expansion, however, would require additional expert input, which could best be provided by forming a panel of European specialist advisers. The present version uses English as a working language but other language versions could be produced if requested.

References

/1/ HELCKE, G.A., PECKHAM, R.J. - The Computation of Degree-days for Use as a Climatic Severity Indicator in EUROSTAT Energy Statistical Tables. EUR 13697 (1991)

/2/ Internalising Environmental Costs, a Survey of Progress in Estimating the External Environmental Costs of Electricity Production and a Review of Market-Based Policies to Incorporate Them

/3/ ETO, J.H., HELCKE, G.A. - Metodi di Stima di Costi Sociali-Ambientali Della Produzione di Energia Elettrica - EUR 13323 IT (1990)

/4/ CONTI, F., HELCKE, G.A., ETO, J.H. - Energia 2/91, pages 12-26. Meccanismi di Mercato ed Internalizzazione delle Diseconomie Ambientali

/5/ CONTI, F., ETO, J.H. - Energia, 3/91, pages 12-24. Social Costs of Energy Consumption.

/6/ HOHMEYER, O., SPRINGER VERLAG, BERLIN-HEIDELBERG, A Detailed Comparison of Energy Audits Carried Out by Four Separate Companies on the Same Set of Buildings (1989)

SUPPORT TO THE COMMUNITY STATISTICAL OFFICE

Statistical Applications of Artificial Neural Networks

The objective of this support activity consists of developing and implementing connectionist tools for statistical applications, namely statistical data estimation, discriminatory analysis and automatic classification. These new techniques are applied for solving various problems selected by the Statistical Office in Luxembourg.

Neural network models are not suited for every problem. Conversely, tasks that are admittedly suitable for a connectionist approach do not necessarily fit the current priorities of the statistical office. Preliminary meetings have resulted in the identification of a set of problems that are both relevant for Eurostat and susceptible of solutions by neural methods. Most of the selected tasks share the following two main features:

- They pertain to the classification framework, either in the context of discriminatory analysis or in that of automatic classification.
- In each data bank to be dealt with, many feature vectors have missing data.

The development of connectionist tools has been directed accordingly.

To prepare the ground for complex classification tasks that would involve supervised learning, like e.g. the selected theme of long-term unemployment characterisation, very recent theoretical results related to the properties of the connectionist multilayer percep-

tron model have been thoroughly reviewed and analysed.

A novel method for missing data interpolation has been derived, and tested with good results on synthetic data. This technique may be used per se, but also offers the noteworthy advantage of performing an online missing data processing, without computational over head, during the unsupervised learning phase of neural models designed to solve automatic classification tasks.

Probably because automatic classification problems are less manageable with traditional statistical methods, most selected applications for Eurostat pertained to this category. Among these, the task of defining a topology of European regions has been addressed in first:

The data consist of 227 European "regions", where "region" may embody anything between a big town and a country. Save on missing data, each of these is characterised by 14 non homogeneous socioeconomic features, like unemployment rate, population density, activity rates a.s.o. The goal is to define a fuzzy similarity measure between these regions, under given exclusion or admissibility constraints. "Kohonen's feature maps", a connectionist algorithm that performs data self-organisation, has proved to be an efficient and flexible tool for this kind of problems. The method allows to deal easily with missing data, weighting of feature components or tightness parameters for the fuzzy clustering. Problems related to the robustness of the data representation with Kohonen maps have been successfully overcome.

SUPPORT TO THE SECRETARIAT GENERAL OF THE COMMISSION OF THE EC

Anti-Fraud Coordination Directorate

In June 1991, ISEI completed a feasibility study for the construction of DAF, a computer documentation system containing descriptions of the national anti-fraud systems in the EEC. The final report of the feasibility study includes the user requirement, the functional specifications for the system, a project plan and resource estimates. The report was circulated to all DGs involved in the anti-fraud domain in September 1991.

In order to facilitate communication with the end-users, ISEI developed a prototype based on commercially available hypertext technology. A series of demonstrations of the DAF prototype took place in Brussels starting in October 1991 with 30 participants representing various DGs.

Based on the lessons learnt from the demonstrations, the comments on the feasibility study received from the DGs and the first experiences with the data collection exercise, the report was modified to reflect the change in the requirements. In a meeting in December 1991 - including participants from Direction Informatique-, ISEI was given full technical responsibility for the development of DAF.

A first work package of analysis work, involving, in particular, the facilities for text-entry and import-into-hypertext, detailed system specifications and a market survey was defined and subcontracted out.

Finally, following an explicit request of the Director of UCLAF, a multi-annual collaboration agreement between the ISEI and UCLAF was prepared and signed.

Development of a Database for the Management of Parliament Petitions

In the framework of support to Directorate E of the Secretariat General, in December 1991 the first version of the petitions database was operative and a demonstration to the User Service was scheduled for January 1992 at Ispra. As a result of the demonstration and testing, as well as changes in the requirements since the time of the preparation of the feasibility study, a second enhanced version of the database will probably be necessary before the system can be installed at the User Service premises in 1992.

5 WORK FOR THIRD PARTIES

Work for third parties was introduced to the JRC in 1988, and is currently a growing activity. ISEI is active in four main areas, which will be described in more detail in the following 4 sections:

- Non nuclear energies
- Environment and industrial risk
- Computer aided engineering
- Training.

The level of contracts signed in 1991 and the forecast level for 1992 is shown in the following Fig. 5.1.

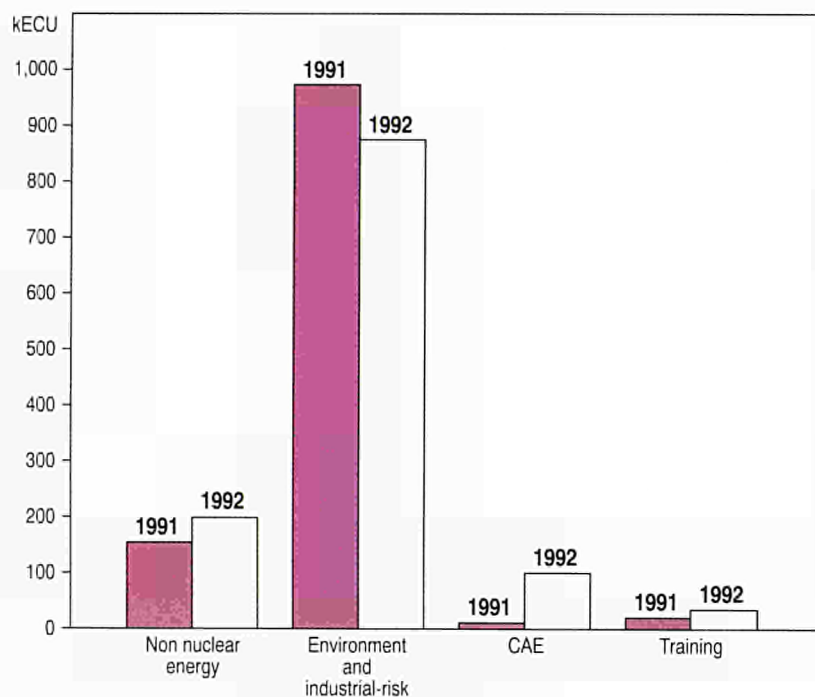In 1992 new markets will be considered and marketing efforts will be increased.

Fig. 5.1: TPW turnover in 1991 and forecast for 1992.

5 WORK FOR THIRD PARTIES

NON NUCLEAR ENERGY

Photovoltaics

Work for Third Parties, i.e. industry and public organisations, against payment is becoming an increasingly important part of ISEI's European Solar Test Installation (ESTI) activities. The following diagram shows the increase in TPW since its start in 1988:
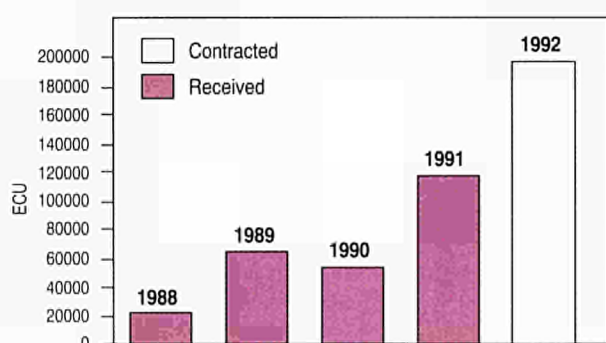

Fig. 5.2: Evolution of Third Party Work in Photovoltaics.

ESTI has a number of advantages which enable it to provide services to industrial clients. Foremost is the neutrality offered by its status as an organisation of the European Commission. This, coupled with the policy of strict confidentiality maintained by ESTI, has encouraged all sectors of the photovoltaic industry to use ESTI.

This situation only became possible following large investments from the Commission's research programmes. Testing and measurement equipment, including several unique test facilities, far too expensive for any single manufacturer to justify, were thus concentrated in one place. To date, ESTI is the only laboratory in the world which can offer the complete package of accelerated lifetime tests, electrical performance measurements (on cells, modules, and complete systems), and device calibration facilities.

Furthermore, ESTI personnel participate in standards organisations (e.g. IEC), making available the experience gained from the tests and measurements routinely performed at ESTI. This participation brings two benefits. It provides a sound technical basis for possible standards and assures the clients that work performed will be conform to future standards.

For example, the module qualification tests implemented now at ESTI are the tests whose requirements will have to be met to obtain IEC type approval. In the absence of any official test laboratory, the ESTI certification is the only independent guarantee of quality to which module manufacturers can refer their clients. As the third party work revenues show, more manufacturers, and the buyers of their products (including institutional buyers e.g. ENEL), are becoming aware of this. Module qualification tests provide the largest fraction of third party work revenues. On several occasions, manufacturers have submitted pre-production modules to assess whether or not a new design can be expected to meet the test requirements. So far, seventeen manufacturers (European, American, and Japanese) have inquired about our testing services; eight have actually sent modules (eighteen different types) to ESTI for testing.

The second largest contribution to third party revenues comes from the calibration of reference devices. These may be single cells or complete modules. ESTI is the only laboratory equipped to calibrate complete modules. The calibrated devices are extremely important to manufacturers assessing the quality of their device production and to plant operators monitoring the performance of complete systems.

Finally, power measurements on completed systems, to determine whether contractual obligations have been met, are becoming more frequent as various photovoltaic programmes (.e.g. the domestic programmes in Switzerland and Germany) proceed. The algorithms and computer codes for extrapolating actual measured data to standard conditions were developed at ESTI, as was the measurement equipment. In 1991 one such measurement at Giubiasco (Ticino/Switzerland) was performed

Development of operative tools for realising energy savings in the building stock of Lombardy

During 1991, the tasks to be carried out under the contract between the ISEI and the Regional Government of Lombardy were completed. The final reports have been published and the results illustrated at a press conference held at Ispra.

The four final products corresponded to the four main

requirements of an integrated approach (see *Fig. 5.3*) to energy saving in the building sector.

These are:

- a comprehensive new database, known as BESIS (Building Energy Saving Information System).

- a study of a possible Building Energy Certification schemes, as required by new Italian legislation and by European recommendations. The report produced on this topic was appreciated as a contribution to the preparation of the Italian norm;

- an experimental study of the use of Building Energy Parameter Identification Techniques for labelling purposes, which involved the monitoring of 3 publicly owned, residential buildings in Varese. This research effort was complementary to other important European studies (e.g. the PASSYS programme) and has considerably enhanced the scientific reputation of the ISEI in this field.

- a new programme, SPIEL-JRC, running on PCs, developed for the integrated assessment of a large number of energy saving measures.

Fig. 5.3: Graphic of Contract between the ISEI Ispra and the Regione Lombardia.

BESIS
(Building Energy Saving Information System)

This is a powerful tool, intended for use by both regional and local governments in planning and by energy professionals for building auditing and energy retrofit design. BESIS makes it possible to store, calculate and supply structured data on the most important physical and energetic parameters of building and plant systems, for energy planning purposes. The picture obtained, of specific consumption by category of use and type of energy vector, permits identification of the most wasteful types of building and consequently the establishment of priorities for action or directed plans.

The information on each building concerns not only the envelope but also the equipment: heating, air conditioning, cooking, refrigeration, lighting and various electrical systems. Therefore, on the basis of the information which will ultimately be available, it will be possible to obtain an updated picture of the types of service/equipment, together with its age, attainable efficiency levels, type of control, adjustment and management, and fuels used.

The calculation modules of BESIS automatically carry out a number of calculations, providing standard energy consumption and indicators for each building. This feature makes BESIS particularly useful, not only as a storage of building stock energy data but also as a preliminary auditing tool for energy saving professionals. In fact, by comparing the values of the energy indicators of a specific building with the corresponding reference and target values it is possible to identify the most important energy saving areas. In addition, BESIS contains a very detailed list of Energy Conservation Opportunities (ECOs), established by a previous international study [IEA Annex 11], improved and extended by subsequent ISEI work. As the energy updating of Lombardy's buildings progresses and the Regional offices feed the consumption data (before and after) together with the ECO specifications into the database, the data bank will give an indication of the technical and economic efficacy of the actions themselves. BESIS is, particularly flexible in receiving data from different data sources and associating a quality index to each set. Data from different sources can be fed into the data base, after suitable conversion and the calculation programmes associated with the database can maximise the content of information available. Particular procedures and files have been foreseen, making
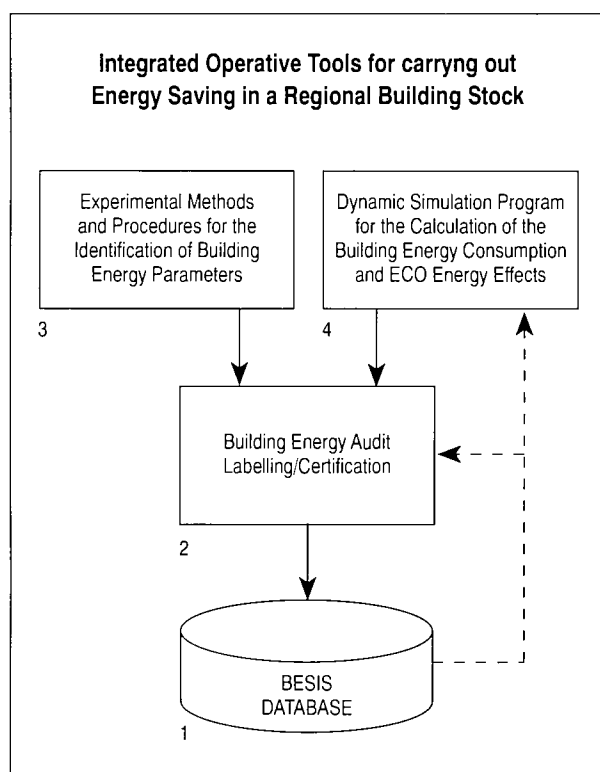
possible the input of data coming from the building energy audit forms requested by the Region of Lombardy, together with the requests for financial support according to the existing Italian laws on incentives and grants.

The main structural components of the BESIS database are:

- The files of "raw data", sets of data on building envelope, various plants and energy saving measures, collected and loaded into the bank;

- The files of "calculated data", derived from raw data by means of automatic calculations;

- The files of "default and standard data", that include the climate, technical, statistical and norm data needed to complete the data set of each building, avoiding a larger and more expensive data collection effort;

- The calculation modules used for providing the calculated data;

- The management modules needed for the input, output, and updating of the data .

BESIS is managed by the DBMS (Database Management System) ADABAS, which makes use of the computer language NATURAL. The programmes of data input, updating and query are written in this language. At present, BESIS is implemented on the mainframe computer of the J.R.C at Ispra, but during 1992 it will be transferred to the UNIX system.

It is important to note that BESIS should not be considered as a tool designed specifically for the Region of Lombardy, since it has general applicability to any European region. It has been presented to a wider audience at the Zaragoza Conference (Energetica '91) in the session devoted to Energy Planning Tools. DG XVII has also received information about it.

Proposals for building energy certification

Building energy certification, as the Danish experience has demonstrated, is a powerful information tool for building owners carrying out energy retrofit work. Following an EC recommendation, the Region of Lombardy asked the ISEI to develop suitable proposals for a test application in a sample of the building stock. In the meantime, building energy certification was introduced in Italy by a new law (no. 10 of 9th Jan.1991). The report from the ISEI, delivered to the Region simultaneously with the issue of this law, has been forwarded by the Region to the Italian Ministry of Industry as one of the most important contributions on this matter. After reviewing the various methods in use throughout the world, a certification method was proposed and tested. The method is based on the calculation of a building energy indicator for space heating. Normalisation factors for the energy consumption should be the heated floor surface area (or the heated volume) and the heating Degree-Days. In order to account for volume and shape effects, the indicator is expressed as a linear function of the shape factor S/V, V being the heated volume and S the surface area enclosing the volume. By means of a standard programme for calculating the building consumption, several curves of the energy indicator were produced, each curve corresponding to different levels of energy efficiency. Energy labels could be attached to a building, according to the performance level or class to which its indicator belongs. Different classes of performance have been proposed with associated justification and with suggestions for differentiated public actions in order to promote energy savings.

The proposals elaborated by the ISEI have been verified for social acceptance. The attitudes (actual and expected) of all the social actors concerned by the certification procedures (Regional and Local authorities, builders, energy professionals, fuel companies, etc.) have been assessed and carefully described, in order to give the promoting authority a clear picture of the social difficulties likely to be encountered in the implementation of building energy certification.

Experimental research on the applicability of Thermal Parameter Identification techniques to building energy certification

An experimental study was carried out, in parallel with the previous theoretical activity, to investigate the feasibility and reliability of a method for directly measuring the building energy performance parameter to be chosen as a basis for building energy labelling The energy balance of an existing building, calculated as part of an energy retrofit or for certification purposes, can involve errors of the same order of magnitude as the potential energy saving. This is because of the appreciable discrepancies which can exist between theoretical and real values of important parameters. Experimental determination of the parameters which characterise the energetic behaviour of buildings can therefore, provide an alternative way of determining energy consumption.

One set of experimental techniques is that of parameter identification, which became a principal line of research in the physics of buildings during the 1980s. The principal objective of these techniques is that of reducing the duration, and hence the cost, of the measurements, guaranteeing at the same time high reliability and reproducibility of the identified parameters. Research is based mainly on what are known as "ex-post" models, which carry out statistical analyses of monitored data from the building, in order to obtain (identify) the necessary parameters. The data generally consist of climatic variables, energy consumption, and internal temperatures. The work was carried out, over a two year period, on 4 apartment buildings belonging to the Institute for Low-Cost Housing (IACP) of Varese.

Various methods were examined, such as the Useful Energy method, the static Building Energy Signature method, and the dynamic Lumped Parameter method, used, with and without Kalman filtering. In particular, the use of Kalman filters makes it possible to shorten the convergence time of the calculation and consequently, if the algorithm is included in the data acquisition system, to reduce to a minimum the time necessary for monitoring a building. In addition, the identified parameters were compared with theoretical values calculated by Italian normative programmes. The identification models were then analysed to compare the difficulties encountered in their application and the results obtainable. Finally, particular attention was given to the data acquisition system, which combined low cost with simplicity of use in order to demonstrate the practical feasibility of the technique.

Development of a new programme (SPIEL-JRC) for the assessment of energy conservation measures in buildings and plant systems

A simulation programme SPIEL-JRC has been developed by the ISEI together with Ecotech Design Ltd., on behalf of the Region of Lombardy in order to supply building and energy professionals with a calculation tool which is more advanced than the static simulation models in use up to now in Italy. This programme should be simpler to use and faster than existing dynamic simulation models, which require a large and expensive data input. The purpose of this programme is the provision of a quick and sufficiently precise tool for evaluating the effects of a large variety of Energy Conservation Opportunities (ECOs). SPIEL-JRC was conceived for the assessment, not only of energy consumption (thermal and electric) but also of the energy savings of various ECOs.

In order to minimise the input data for building envelope and equipment (HVAC, cooking, electricity), the programme makes extensive use of default data stored in associated files. Different default data are available according to the building category (residential, schools, offices, etc.) and plant types. Many algorithms in the programme are the result of empirical analyses of a considerable amount of real data. Future validation of the programme will make improvements possible but the results are already comparable with those of more sophisticated simulation programmes. Its design is a compromise between the sophistication and complexity of the algorithms and variables to be considered and the requirements of speed, reduced input data, and PC memory constraint. The programme is written in C language and compiled for DOS using Micro-Soft Version 5.1 of C compiler and is designed to run on IBM or compatible PCs under DOS with a limitation of 640 kB of internal memory.

Spiel-JRC is not a simple programme but is simplified as much as possible. It can simulate up to 300 different combinations of building uses, fuel and emitter, types, heating and cooling modes, control schemes, etc. A building can be simulated iteratively with different configurations of building elements, plant types, and user behaviour. Users can make their choices quite easily by means of a MAIN MENU and pull-down sub-menus. The programme works on an hourly basis and can simulate up to 8 building zones by means of a lumped parameter R-C model. The thermal balance is described by differential equations with the node temperatures as unknown variables, which are solved with a finite difference algorithm having an integration time step automatically determined and optimised.

ENVIRONMENTAL AND INDUSTRIAL RISK

Application of COSIMO to the AEA Winfrith Operators

The model COSIMO was tested in relation to the behaviour of real operators at the nuclear installation at Winfrith Technology Centre (WTC). An analysis has been performed of the cognitive processes of an operator controlling the training simulator of the nuclear power plant, the Steam Generating Heavy Water Reactor, SGHWR. The objective of the research was to analyse an operators cognitive processes in a problem solving situation, by focusing on aspects related to information checking and actions to be taken. Five accident transients on the simulator were selected. Four operators participated in the experiments, three reactor foremen and one fuel foreman. Current techniques of observation and of protocol analysis have been employed for exploring cognitive processes. The data analysed allowed to build up a knowledge base which corresponds to the knowledge an operator uses to solve the incidents that may occur and to evaluate whether the cognitive primitives and the formalised knowledge in the model are the same as those used by the operator in control of the SGHWR.

In the context of the contract, the software COSIMO was ported from a Lisp machine environment to a Unix environment and was then applied to the specific case of the control operation of the SGHWR.

"Statistical Analysis of ENEL data stored in the Component Event Data Bank and comparison with analogous data related to other European plants" - Contract with ENEL CRTN Milano

ISEI has undertaken under contract No 3842-89-11 TG ISP I to carry out research and applications activities to compare the performance of ENEL components stored in the CEDB (the component event reliability data base operated by ISEI) to that of other data suppliers. The components compared are electric motors.

Seven strata of electric motors were defined by "Intelligent selections" on the data base where testing was consequently carried out.

Parametric and non-parametric comparisons between data suppliers have been implemented in each stratum. Both methods are consonant on strata encompassing most of the operating experience of the components in the data base. Studies for trends will be carried out for strata where methods produced significant findings. Non-parametric methods based on empirical bayes estimates of the failure rates of components will be carried out in the next phase of the contract.

Assistance to the National Nuclear Safety Administration (NNSA) of the People's Republic of China

In the framework of the People's Republic of China - CEC Energy Cooperation Programme, established in October 1987, one aim of which was to create in China a "Nuclear Safety Information Centre", the ISEI was asked by DG XVII to collaborate with NNSA in order to set up in China a system of data banks analogous to the European Reliability Data System (ERDS). A special version of the Abnormal Occurrences Reporting System (AORS) and of the Component Event Data Bank (CEDB) of ERDS were installed in 1989 into the Cyber computer at the headquarters of NNSA in Beijing.

The work carried out in 1991 in Beijing was:

- to implement at Beijing a thoroughly revised version of the software of the AORS and CEDB systems - to discuss with the plant operating staff the basic criteria for the selection of systems and related components to be monitored at the Qinshan Nuclear Power Plant
- to identify plant equipments relevant to safety and important for plant availability for production
- to give seminars on the use of data and on the methods of data analysis developed by the ISEI.

Esprit II - BR - MOHAWC

The cognitive model Cosimo has been developed to simulate human decision making and behaviour in complex working environments. The model is used to

study human behaviour in simulated accident situations and to identify suitable safety recommendations as well as reliability and effectiveness of procedures. The domain in which the model has been applied is supervision and control of nuclear installations. The model is embedded in dynamic environments in which incoming cues of data describing the environment vary both as a consequence of the models previous outputs and of the spontaneous activity of the physical system under control.

Stress modelling for the CNR-PF FATMA

In working environments, people workload can become extremely high in periods of intense activity. This problem is recognised as a major cause of operators stress. However little is known concerning the effect of stress on reasoning and on cognitive processes such at attentional processes and decision making. Errors are very likely to occur in stressful situations, which is another crucial problem to understand for errors explanations and prevention. A literature analysis allowed to understand how do people reason and how they change their strategy when the workload is high.

City of Venice

ISEI is acting as consultants in the "Commissione per la predisposizione di un progetto di informazione alla popolazione" of the City of Venice for the provision of information to the public on major accident hazards according to DPR 175/88 and Decreto del Ministero dell'Ambiente, 20 maggio 1991, implementing the Seveso Directive. Reports have been produced and a proposal for a further 3 year collaboration has been made. These reports include:

- An evaluation of the state of the art and illustrative examples of implementation of the Directive in several countries.

- A proposal for a campaign of information to be conducted on an experimental "module" that includes the area most exposed to the hazard. This "module" differentiates among several contexts and population groups, and can be extended to other areas.

MAPO - Master Plan for the Po River Basin

Background

The initials MAPO indicate a decision support system for the management of planning and control of the cleaning up of the river Po. The work is financed by the Italian Ministry of the Environment. The Po-basin is the largest in the country. Most of the work related to the MAPO project was carried out in 1991.

The objective of the MAPO system is intended to give scientific support to the decisions of the organisation responsible for carrying out the clean up of a large river basin. This support will be given by the evaluation of alternative plans of action, and aid to the decision maker in making rational choices based on these evaluations. The alternative plans will be characterised by costs, environmental and social impacts.

The philosophy behind the system is that relevant information about the environmental problem under study is extracted from existing databases which are part of a remote Geographical Information System (GIS). This information is then passed, together with user defined information about specific high level goals, to the expert system module. This module then generates the actual alternatives which satisfy the initial high level goal of the decision maker. These alternatives are then examined using decision techniques to arrive at a (number of) preferred solution(s). The concept is illustrated in Fig. 5.4.
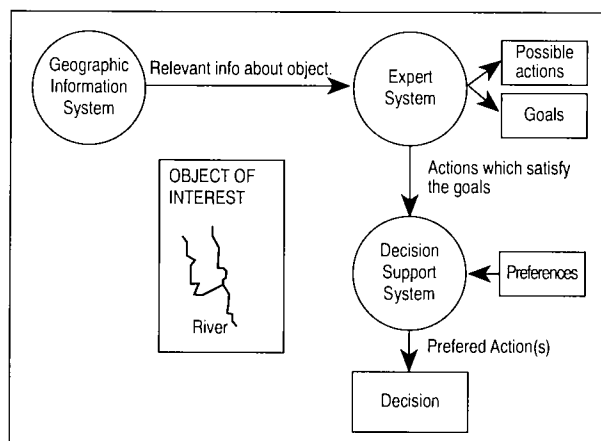

Fig. 5.4: Concept of the MAPO system.

The MAPO system was designed in 5 blocks:

- User Interface
- Decision support module
- Expert system module
- Input control module
- Communication module

The 5 modules are connected as indicated in *Fig. 5.5*.

The decision support module is based on the idea that decisions within the environmental field con only be made on more than one criterion. In other words, it is not possible just to evaluate alternatives (and status quo) on one (even aggregated) scale. Multi criteria are needed. The MAPO system is therefore implemented using the framework of Multi Criteria Decision Aid (MCDA) theory. Within MCDA two approaches are possible, one in which the problem space can be considered as continuous, and one where the problem space is discrete. In the MAPO system both approaches have been used. For the continuous approach this is implemented in two steps:

- multi objective linear programming to find the non-dominated set of solutions by means of the simplex technique,
- the reference point method for building a ranking between non-dominated alternatives.

The Expert System module uses knowledge organised into three blocks:

K1: basic knowledge about the object under study (the Po river)

K2: explicit problem solving knowledge

K3: transitive knowledge to estimate the effects of the various actions proposed

The knowledge paradigm used is that of FRAMES and RULES.

The communication module performs heterogeneous exchanging of data and commands between the local MAPO node, which is a Unix workstation, and the remote Geographic Information System and database server, which for the design has been specified as a Vax running VMS. The communication module uses a simple model of one-to-one communication and the TCP/IP protocol which is available both on local area networks and on wide area networks, for instance over X25.

The user Interface module is responsible for all interaction between the system and its users, providing a consistent and friendly communication. It requires a screen, a mouse and a keyboard and uses high quality colour graphics. From a functional point of view the user interface module is based on a convenient arrangement of nine different types of window that manage four components (static messages, dynamic messages, menus, graphics).

The user interface is implemented using the X windows software developed by MIT, using the release X11.5 which is available for the general public without costs.

An example of the user interface, with geographical data for the whole Po river basin is shown in *Fig. 5.6*.
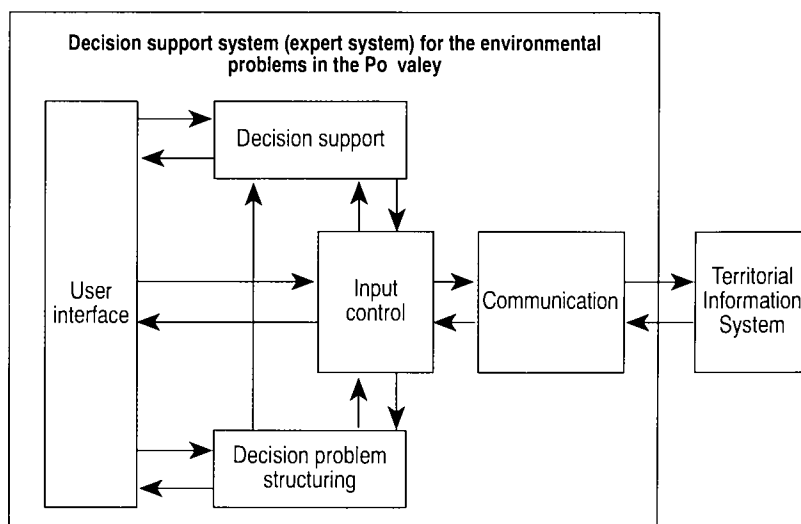
The MAPO system is being developed as an experimental prototype. In order to verify the functionality of the system architecture a simplified case study is being used. This has permitted the verification of the possibility to integrate:

- a decision support system,
- an expert system for structuring knowledge,
- a remote Geographic Information System.

The collection and organisation of the full set of information for the Po Basin is still under way. When completed this will permit the system to be fully operational.
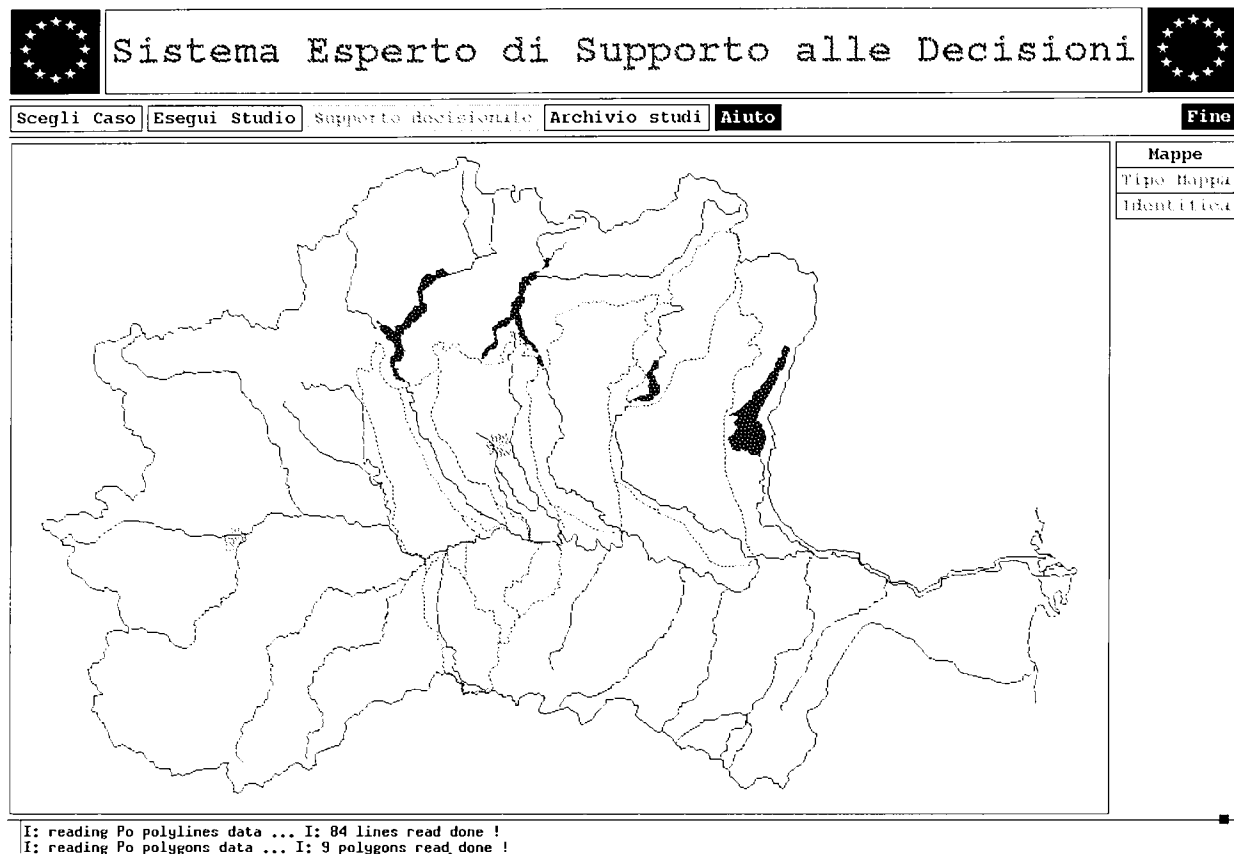

Fig. 5.5: Block diagram of the MAPO system.

Sistema Esperto di Supporto alle Decisioni

| Scegli Caso | Esegui Studio | Supporto decisionale | Archivio studi | Aiuto | Fine |

Mappe
Tipo Mappa
Identified

```
I: reading Po polylines data ... I: 84 lines read done !
I: reading Po polygons data ... I: 9 polygons read done !
```

Fig. 5.6: Example of user interface with map of the Po Basin.

The RITO (Rifiuti Industriali Tossici) Project - a DSS for Industrial Waste Management

The RITO (Rifiuti Industriali TOssici) project aims at developping a DSS for hazardous industrial waste management and disposal on the regional scale. The scope of RITO is to provide scientific support to decision makers for siting of disposal plants and choosing the best composition of available technologies (e.g. incinerators, controlled landfills, etc) with the constraint of disposing all produced waste in the region of production.

The project required the collection of data on the quantification of the streams of toxic waste, the geographical siting and capacities of the disposal facilities and the characterisation of the hazard properties of the waste. The system simulates the disposal phases starting from temporary storage, passing to the treatment, destruction and final disposal. Different

planning scenarios for building new plants con be identified and generated for purposes of comparisons. The alternative scenarios are evaluated in terms of their costs, risks and environmental impacts, and these evaluations lead to indices which are used in the decision aid. For the decision procedure , the discrete approach using pairwise comparison (as implemented in. ELECTRE, MAPPAC and PRAGMA) has been adopted. *Fig. 5.7* shows the functional decomposition of the RITO prototype. This comprises the scenario generation module, modules for the assessment of risk, cost, environmental impact, and transportation, linked together by a customised user interface. The GEOSCOPE Geographical Information System has been used for geographical data preparation, storage and presentation.

RITO is currently prototyped on an IBM-PS II personal computer, under the MS-DOS operating system and within the "Windows 3.0" environment. The C programming language and libraries have been used for development.
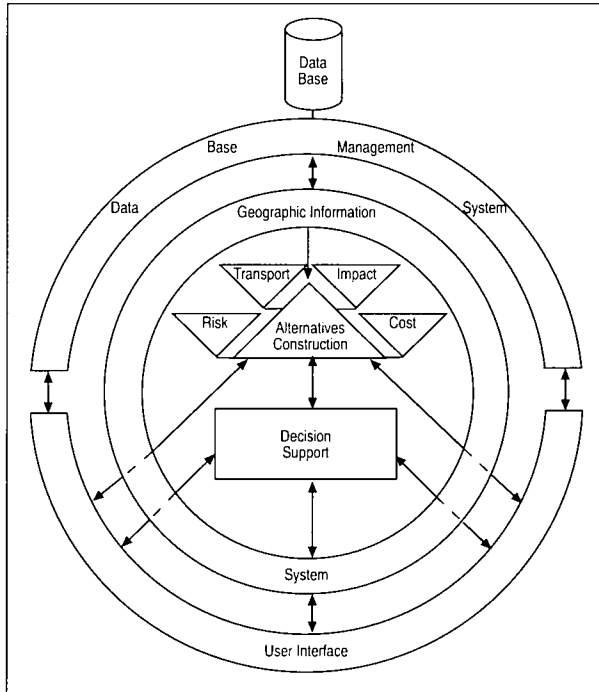
Fig. 5.7: Functional decomposition of the RITO prototype.

BRITE Project 2124

Objective: Development of and implementation of the prototype of an expert system for maintenance and inspection optimisation in nuclear reactor pressure vessels and in off-shore structures.

The project ended in July. A prototype of the knowledge based system RAMINO (Reliability Assessment for Maintenance and INspection Optimisation) has been implemented, containing the basic knowledge to perform the reliability assessment of a structure starting from inspection data. A "default base " of data and knowledge has also been implemented to allow a "conservative" assessment when some information on the very structure is not available.

SIAI MARCHETTI

Objective: Laser holographic measurements on aircraft fuselage undergoing fatigue damage.

The first campaign of interferometric measurements has been carried out in SIAI factory at Sesto Calende to identify the time zero situation. The presence of parosite vibrations did reduce the effectiveness of the method (a continuous wave laser was used). In order to overcome these difficulties, the pulsed wave laser should be used in the next campaign.

COMPUTER AIDED ENGINEERING

Among the various works done in the field of Computer Aided Engineering, two of them were performed as first tentative to enter new markets.

The first one was dealing with the contribution to the development of an intelligent robot gripper, and the second one with the structural analysis of automotive components in general and steering wheels in particular.

For next year, the potential market for structural analysis identified so far may reach 100KECUs.

TRAINING

Civil Protection Courses

Scientific papers have been presented at several international meetings, and lectures delivered at different courses of Civil Protection, including two courses sponsored by the European Social Fund, the "Corso per tecnici di protezione e sicurezza del lavoro", held at the JRC - Ispra in collaboration with the Regione Lombardia, and the "Curs de gestis dels recursos naturals I avaluacis de l'impacte ambiental", held in Palma de Maillorca. In the first course, advice was given to a thesis on the implementation of art.8 of the Seveso Directive. Since very good feedback is being obtained these training activities will expand next year.

Petrobras, Petroleo Brasileiro S.A

A complete "Reliability Data Banks" Course was given to a group of engineers at the headquarters of Petrobras in Rio de Janeiro. The attendants to the Course were persons involved in plant operation and maintenance as well as in the development of a Component Data Bank for the collection of data in the various establishments of the Company (refineries, off-shore platforms etc) and in their future analysis.

EXXON

A one week seminar was organised as a Third Party Work activity for EXXON Research & Engineering (ER&E) - New Jersey. The seminar took place at the JRC and focused on the ISEI methodology and tools for carrying out process plant safety assessment and management. The seminar covered issues such as knowledge based hazard identification, fault tree analysis, computer aided fault tree construction, residual life time prediction of structural components, human reliability assessment and cognitive modelling, consequence assessment and vulnerability analysis. A useful discussion was held on ongoing R&D projects such as STARS and FORMENTOR. A short presentation of the documentation centre on Industrial Risk(CDCIR) concluded the seminar.

6 ASSOCIATED LABORATORIES

Partners in Collaborative Projects

Associations

Exchange of Experts

94

*ISEI has formal collaboration with a number of institu-
tions and other organisations, which is also seen
throughout the first five chapters of this annual report.
In the following, these collaborations are listed.*

6 ASSOCIATED LABORATORIES

PARTNERS IN COLLABORATIVE PROJECTS

STARS (Software Tools for Advanced Reliability and Safety Analysis)

Partners:

- Institute for Systems Engineering and Informatics of the JRC (I)
- RISØ National Laboratory of Denmark (DK)
- VTT - Technical Research Centre of Finland (Safety Engineering Laboratory) (SF)
- TECSA SpA (I)

Affiliates:

- TNO (NL)
- Framatome (F)
- ABB (S)

FORMENTOR (EUREKA #19)

Partners:

- Institute for Systems Engineering and Informatics of the JRC (I)
- CAP Gemini (F)
- DnV (N)
- Aerospatiale (F)

Application provider:

- BP (UK)

TOMHID

(an overall knowledge-based methodology for hazard identification) in the frame of the **CEC STEP** (**S**cience & **T**echnology for **E**nvironment **P**rotection) programme

Partners:

- Institute for Systems Engineering and Informatics of the JRC (I)

- RISØ National Laboratory of Denmark (DK)
- VTT - Technical Research Centre of Finland (Safety Engineering Laboratory) (SF)
- Sheffield University (UK)
- AEA - SRD (UK)
- Ciemat (E)
- TECSA SpA (I)

HEAT
(Human Error Analytical Taxonomy)

Partners:

- Institute for Systems Engineering and Informatics of the JRC (I)
- TECNIMONT (I)
- University of Siena (I)
- VTT - Technical Research Centre of Finland (SF)
- Rohm and Haas (UK)

SRG
(System Response Generator)

Partners:

- Institute for Systems Engineering and Informatics of the JRC (I)
- Computer Resources International A/S (CRI) (DK)
- Aerospatiale Protection Systems (APSYS) (F)

ASSOCIATIONS

Eurosafe Club

The purpose of this Club is to argue for and prepare the creation of a European Economic Interest Group in the field of risk management bringing together the following companies and organisation:

- Aerospatiale Protection Systems (APSYS) (F)
- Institute for Systems Engineering and Informatics of the JRC (I)
- Computer Resources International A/S (CRI) (DK)
- Four Elements LTD (UK)
- SNPE Ing. SA (I)
- TECSA SpA (I)
- Tecnologias y Sistemas de Seguridad SA (E)

ESReDA
(European Safety, Reliability & Data Association)

EuReDatA (European Reliability Data Bank Association) and ESRRDA (European Safety & Reliability Research and Development Association) merged into ESReDA, where the ISEI has been instrumental in fostering the take off phase organising the ESRRDA Seminar on "Operational Safety" (Düsseldorf, 17-18.4.1991) and the 1st ESReDA Seminar on "The use of Expert Systems in Safety Assessment and Management" (London, 9.10.1991) and the associated Proceedings.

Membership in ESReDA is steadily increasing drawing on some hundred correspondents.

EXCHANGE OF EXPERTS

ISEI maintains exchanges of experts with the following institutions:

Electricité de France

In the frame of the collaboration with EdF-DER/IMA/MMN, related to the Application of Transient Electromagnetic Models and Codes, including Magneto-Structural Coupling, N. Richard has been seconded as visiting expert to ISEI during all the year 1991.

ISIG

The Institute of International Sociology - Gorizia (ISIG) has seconded to the JRC/ISEI, Dr. Bruna De Marchi, specialist in the field of mass emergencies and risk communication.

CSN
(Consejo de Seguridad Nuclear - Spain)

A collaboration between ISEI and CSN started in 1987 with a feasibility study for coupling the TRETA code with the DYLAM code. During the secondment of an expert from CSN, E. Meléndez, a well structured link between the two packages has been developed.

7 PARTICIPATION IN EUREKA PROJECTS

FORMENTOR

98

ISEI participates in EUREKA #19 project, FORMEN-TOR, details of which can be found in the following sections.

PARTICIPATION IN EUREKA PROJECTS

FORMENTOR

The FORMENTOR project (Eureka #19) is developing decision support systems for operators of complex hazardous plants. The partners in the project are:

- ISEI
- Aérospatiale (F)
- Cap Gemini Innovation (F)
- Det norske Veritas (N)

FORMENTOR systems are intended to offer real-time decision support to operators of complex installations to help to manage potentially hazardous situations. The FORMENTOR project is oriented in particular towards abnormal or unusual situations, in which the plant is functioning outside its normal operating boundaries and the operator's actions are guided by safety considerations /1/2/.

The work of the FORMENTOR project is divided into various workstreams. In the course of 1991, these workstreams progressed as follows:

Two Pilot Applications were launched, in different industrial domains.

- The Satellite Pilot Application deals with the ground manipulations of a cryostat for use in a satellite. This Application was carried out essentially by the French partners, Aérospatiale and Cap Gemini Innovation. The Application started early in the year with a definition phase, and then proceeded to knowledge elicitation and system development. By the end of 1991, the functionalities of this FORMENTOR Application had been fully defined and partially implemented. Full implementation and integration is planned for mid-1992.

- The Chemical Pilot Application concerns the control of a butadiene extractive distillation plant. A preliminary definition phase for this Application was finished early in 1991, in cooperation with British Petroleum, owners of the plant concerned. In June 1991, British Petroleum and the FORMEN-
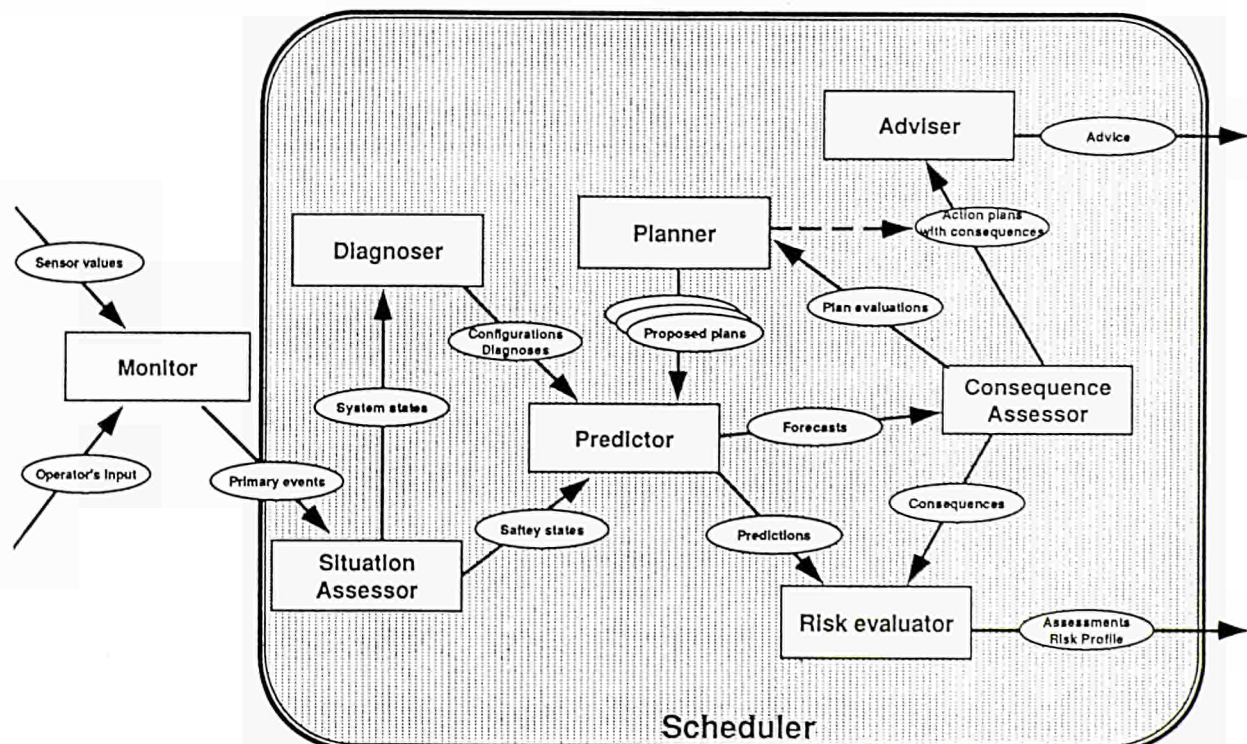

Fig. 7.1: The FORMENTOR Architecture.

99

TOR consortium entered into an agreement to develop the Pilot Application together. The FOR-MENTOR contribution to this Application comes from the ISEI and Cap Gemini Innovation, with ISEI staff leading the Application. During 1991, detailed knowledge elicitation and high-level system design was carried out; at the end of the year this work was virtually complete, with system implementation planned for 1992.

A start was also made on building a third FORMEN-TOR pilot system. This pilot system is a case study, intended to enable the testing of different formalisms for system modelling and different system architectures; the installation chosen is the emergency cooling system of a nuclear power plant at design stage. This work, carried out largely by ISEI staff, turned out to be of considerable help in defining the choices available for the pilot applications, and the various workstreams have been kept in close contact to this end. Methodological work was carried out in parallel with the application developments, and involved the study and choice of techniques from a wide range of disciplines needed for successful implementation of FORMENTOR systems. In addition, towards the end of the year a start was made on the "FOR-MENTOR Toolkit", with a definition of the functionalities needed and a preliminary definition of the FOR MENTOR architecture (see *Fig. 7.1*).

References

/1/ POUCET, A., NORDVIK, P., MITCHISON, N. - "Knowledge-Based Systems and Machine Learning for Enhancing Plant Safety". In: Proceedings of the 13th World Conference on Computation and Applied Mathematics, pp. 1364-1365, IMACS, Dublin (1991)

/2/ "FORMENTOR: des systèmes experts temps réel pour la surveillance" in La Lettre de la Sûreté de Fonctionnement, no. 18, pp. 9-11, Paris, March 1991

8 SPECIAL COMMISSION PROJECTS

**EQHHPP - The Euro-Quebec
Hydro-Hydrogen Pilot Project**

SPECIAL COMMISSION PROJECTS

EQHHPP - THE EURO-QUEBEC HYDRO-HYDROGEN PILOT PROJECT

The 100 MW pilot project is to demonstrate the provision of clean and renewable primary energy in the form of Quebec hydropower, converted via electrolysis into hydrogen and shipped to Europe, where it is stored and used in different ways: electricity/heat cogeneration, fuel cell operation, power/drinking water generation, vehicle and aviation propulsion.

The project is sponsored by the Commission of the European Communities and the Government of Quebec.

The project is based on a concept conceived by the Joint Research Centre of the CEC and is carried out by a group of industrial firms/institutions. A Joint Management Group looks after the project management and the ISEI coordinates the project.

Milestones of the Project

The project is to be carried out in 4 Phases:

Phase I: assessment; completed by March 1987.

Phase II: detailed system definition, 1.1.1989-31.3.1991.
             supplementary task, 1991-1992.

Phase III-0: • investigation for Phases III & IV.
             • hydrogen applications demonstration projects, 1992-1993/94.
             • operation of the demonstration projects + complementary studies, 1993 - about 97.

Phase IV: detailed engineering & specifications; planned to last 1-2 years.
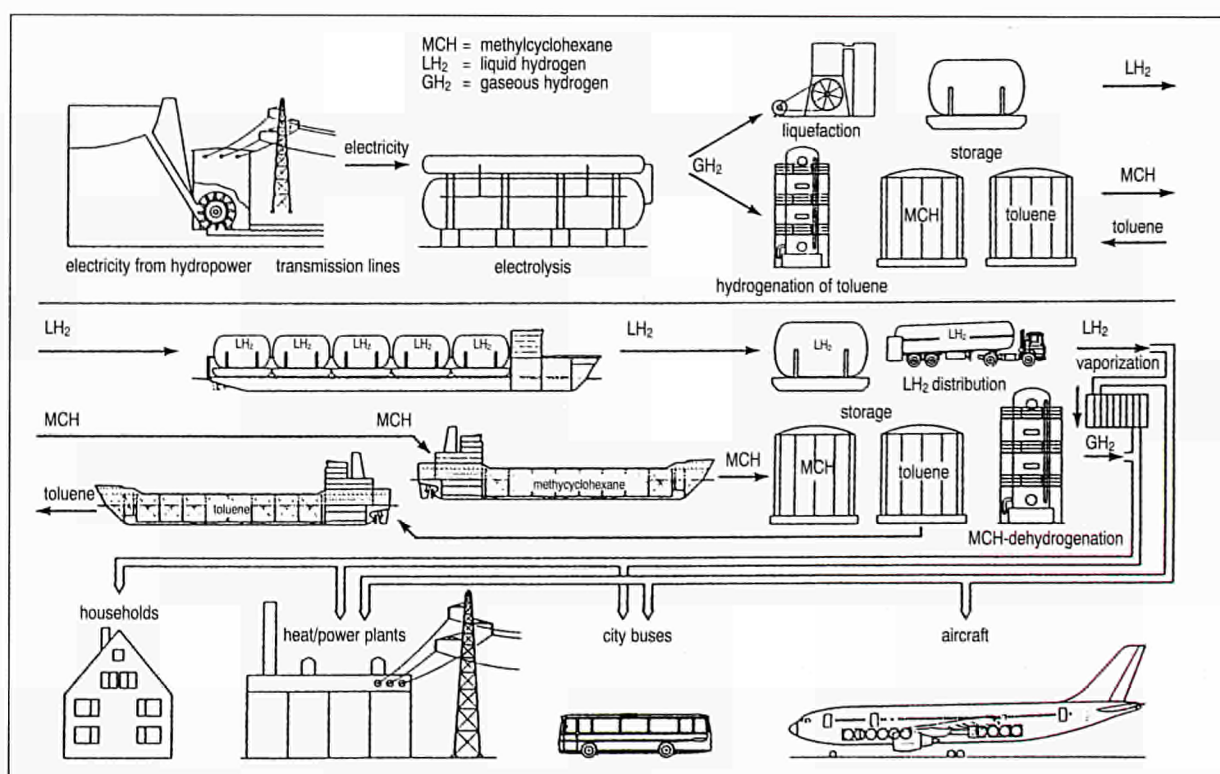
Phase V: construction; planned to last 4-5 years.

Fig.8.1: The Concept of the EQHHPP Project Milestones of the Project.

Progress up to 1991

For reasons of thermodynamic properties, availability of technology and end use, two different modes of vectorisation have been investigated namely liquid hydrogen LH2 and methylcyclohexane (MCH) in order to have hydrogen in both forms, liquid and gaseous, available for the end use requirements. Weighting the advantages/disadvantages of the LH2 vs MCH vector, it was decided to abandon the latter. With that, the following main characteristics of the system for the reference case, i.e. the LH2 vector, have been elaborated:

- hydropower 100 MW
- electrolysis (net) 74%
- annuity (8% interest, 15 yr pay back) 11,7%
- load factor 95%
- hydrogen delivered in Hamburg 74 MW = 614 Gwh/y
- hydrogen transmission efficiency 74%
- total energy transmission efficiency 45-60%
- plant investment costs 415 Mio Ecu
- specific hydrogen energy costs 14,8 cECU/kWh

ISEI Activities

ISEI is the coordinator of the project. A part from the project coordination activities posters and exposés were prepared and support and collaboration were supplied for hydrogen Symposia and Exhibitions such as:

- Hydrogen Exhibition at the European Parliament, Strasbourg, June 1990.
- Rassegna Internazionale - Elettronica, Spazio, Energia, Rome, November 1990.
- Hydrogen: The Fuel Beyond the Fossil Fuels, Bruxelles, April 1991.
- Hydrogen within a Clean and Renewable Energy System, Genova, October 1991.

The following contracts for the demonstration programme on the utilisation of hydrogen in five fields (Phase III.0-2), have been finalised:

- public transport
- aviation propulsion
- steel fabrication
- cogeneration
- storage technology

9 LARGE INSTALLATIONS AND SERVICES

ESTI

STRIKE

Pulsed Wave Laser Laboratory

Telemac Laboratory

General Design Office

Informatics Services

The Institute runs a number of large installations and services of general interest which can also be used for contract research. There are six such services and installations:

- European Solar Test Installation (ESTI).
- Structural Reliability Investigation by Knowledge Engineering (STRIKE).
- Pulsed Wave Laboratory.
- TELEMAC Laboratory.
- General Design Office (B.E.G.).
- Informatics services.

These are described in the following sections.

9 LARGE INSTALLATIONS AND SERVICES

ESTI

The Facilities of ESTI (European Solar Test Installation) are used to develop methods and equipment for tests on photovoltaic solar cells, modules and systems. These tests are executed mainly on request by industry or are embedded in collaboration with other laboratories. In 1991, the major use of the installation was for calibration and qualification of commercial photovoltaic products.

Output in 1991:

- Calibration of 12 radiation sensors by indoor and outdoor methods.
- Qualification tests according to Spec.503 for 11 types of photovoltaic modules, 8 of which received a certificate for meeting the criteria.
- Electrical Performance tests on more than 500 devices.

- First industry-requested execution of the "Current-Voltage Timing" measurement technique as developed by ESTI in 1990.

New facilities:

- A new Large Area Pulsed Solar Simulator (LAPSS) was installed. This machine is optimised for a long flash duration and allows ESTI to increase accuracy on calibration of advanced high-efficiency devices.
- A fully computer controlled facility was implemented which allows to perform the three outdoor tests as specified by the EUR/ESTI Spec.503 simultaneously. In 1992, it will be also used for the definition of a new standards proposal on performance rating.

STRIKE

STRIKE (Structural Reliability Investigation by Knowledge Engineering) is a fully equipped laboratory constituted by two experimental facilities:

- **Vessel Test Rig** where it is possible to perform fully automatic, unsupervised long running fatigue tests (pressure, vibrations, flexural) and burst tests.
- **Thermal Shock** where it is possible to perform fully automatic, unsupervised tests of repeated thermal shocks or thermal fatigue.

In both the test rigs the following facilities are available:

- data collecting unit
- automatic scanning devices for Ultrasonic inspection

- automatic continuous monitoring of critical regions by Ultrasonic method
- continuous monitoring by multichannel Acoustic Emission system
- laser holographic interferometric system for experimental strain analysis
- system for residual stress measurement
- systems for standard measurements: strain, temperature, pressure, water chemistry, water flow rate, etc.

The experimentation can be supported by groups performing: FEM stress analysis, knowledge engineering application, development of mathematical models, reliability assessment, lifetime prediction, fracture mechanics.

PULSED WAVE LASER LABORATORY

The Pulsed Wave Laser Lab (which is part of the Laser and Applied Optics Lab) is equipped with a 3 joule, pulsed wave, ruby laser which allows the execution of high resolution (better than 1 micron), non contact measurements of:

- surface strain by holographic interferometry;
- vibration analysis by interferometry
- surface geometry characterisation by contourig method

The use of a pulsed wave laser allows to get rid of any problems caused by spurious vibrations. The laboratory is fully equipped with the relevant facilities, e.g.:

- holocamera system;
- thermoplastic film recording system;
- holographic plates recording system;
- ESPI system;
- optical fibres holographic endoscopes;
- computer system for on-line image analysis.

The Lab can be supported by the Image Acquisition and Processing Laboratory and by the Continuous Wave Laser Lab.

TELEMAC LABORATORY

Objective of the TELEMAC Laboratory

The TELEMAC Laboratory is dedicated to the Design, Reliability Analysis and Testing of Remote Handling Equipments and Operations, and to the Validation of numerical simulation Results by Experiments on Mockups.

The main current activities in the frame of the JRC Fusion Technology and Safety Programme concern the studies on Remote Handling of the internal components of Fusion Reactors.

Particular consideration is devoted to Safety Related Problems, such as Collision Avoidance, Path Finding, Impact Analysis, Remote Handling Control Workstation, Containment of Tritium and Activated Dusts.

In the meantime, the Reliability of Remote Handling systems and Robotics, including both Software and Hardware Reliability aspects, are investigated.

The TELEMAC studies contribute in such a way to assess the Safe Maintainability and Operability of the future Fusion Reactors.

Ways and Means

TELEMAC is based on a dual approach to teleoperation and robotics problems: Computer simulation and Experimental validation.

The activities are focused on:

- Advanced Computer Simulation System
- Facility for Validation tests on 1/3 scale mockups

An integrated Advanced Computer Simulation System supporting the design of remote handling equipments for the assembly and maintenance of a nuclear fusion plant has been developed. The support provided by the system is based on simulation techniques: kinematic, dynamic and visual simulation. The system accepts design models of remote handling equipments and environment created using CAD system, and supports the assembly of the robot.

The purpose of the Facility is to validate the results of the simulation activity on reduced scale mockups. In order to perform this activity, a large gantry robot, the ROBERTINO facility was installed above the 1/3 scale mockup of a sector of the NET/ITER fusion reactor.

This Facility is now used to verify the NET/ITER concept for the top loading of the First Wall and Shielding Modules. It is conceived in a flexible way to be able to verify any possible scheme for the assembly and maintenance of the future Fusion Reactors.

GENERAL DESIGN OFFICE

The BEG (General Design Office) is engaged in design works to be carried out for the laboratories of the JRC. There are 3 distinct activities running in this sector:

- Construction design (design and construction drawings for experimental facilities).
- Finite element analysis (complex structural and thermomechanical modelling also for Third Party programmes).
- Advanced 2D & 3D presentation graphics.

All these activities are carried out using the most modern CAD/CAE tools like: MEDUSA CAD package, PATRAN CAD package, ABAQUS and P-Thermal FEA codes, etc. For the first two activities listed above, there is a close collaboration with the Conceptual Design sector, which performs the same activities in the frame of the Fusion Programme.

The main projects in which BEG has been involved during 1991 are:

LOBI (Reactor Safety): Support work before closing down of the programme (July 1991).

FIRES (Industrial Risk): Design work for containers, piping system, pumps and special components.

FARO (Reactor Safety): Thermodynamical calculations for the UO2 - release system: design of release valve and auxiliary tank for melting inox.

LTDF (Dynamical Tests): Design of components, load system and specimens.

Fusion Technology: Thermal and mechanical computation related to LOCA (Loss Of Coolant Accident) using the finite elements method.

Furthermore, the activities of BEG include engineering consultancy on specific problems or topics as thermodynamics, cryogenics, and in the electrotechnical field.

Training of students on CAD techniques is also regularly undertaken at BEG.

The demand for engineering services has always been very high. In particular, concerning the above mentioned activities, the situation can be summarised as follows:

Construction design: Even if work is often given to external firms, the private support cannot substitute the services offered by the ISEI, first of all because of the continuous contact between committing laboratories and design office.

Finite elements analysis: There is an increasing demand for numerical support, both from laboratories and programmes.

Advanced 2D & 3D presentation graphics: Demand for this activity is high and is expected to grow.

INFORMATICS SERVICES

The ISEI runs a number of services of general interest which provide a common operational infrastructure for the benefit of the Ispra Establishment and the JRC as a whole.

Such services have been the subject of a profound revision in the light of the customer/contractor paradigm that takes into account the increased responsibility of Institutes for the organisation of their own informatics support.

As the result of a joint effort involving both users and service providers, the "JRC Informatics 2000" document was produced. This important exercise was carried out in the framework of the overall JRC strategic plan reflections. Informatics services which ISEI is now committed to offer to the other Institutes, emerge from specific bilateral or multilateral negotiations aimed at the definition of agreed service quality levels and the associated operational resources and investments.

For their part, individual Institutes have produced strategic guidelines for the evolution of their sectorial informatics environments. The overall objective of this planning exercise is to make a measurable improvement in the quality and efficiency of the use of information technology in the house.

The recommended technical/organisational measures can be summarised in the following points:

- an increased inter-institute coordination. In particular the role of the Information Systems Managers and their Committee has been strengthened.
- a move in the direction of distributed informatics, open systems architecture and internet working. This implies a coordinated support of shared servers, workstations, network management and networked system administration for the benefit of multidisciplinary JRC internal projects and external collaborations.
- the modernisation of the support to the administrative workflow and procedures including new facilities for the scientific management tasks such as planning, monitoring and evaluation.
- an enhanced dissemination, security and safety of information relevant to the working environment combined with a continuous and capillary education and training effort.

The first round of the customer/contractor negotiations has resulted in the transformation of the previous rather monolithic service organisation into a set of services addressed to specific user populations and needs which are separately financed and controlled. Informatics services have been reorganised around the following principal themes:

- Administrative server. The concept of a general purpose mainframe processing unit that serves a mix of administrative and scientific load has been abandoned. Scientific processing is being moved to more effective computational engines. The current mainframe will be substituted by a cheaper transaction oriented installation. A special effort will be devoted to the re-engineering of the administrative applications in order to prepare for the final porting to open system platforms and, possibly, the adoption of next generation transaction processing systems.
- JRC wide network. The inter-site communication bandwidth across the international public services needs to be reinforced. This includes the connections to the existing and future high speed networks for the European R/D community. An enhanced international connectivity is instrumental to a number of scientific ventures which require the intense sharing of computational resources with national laboratories.

Ispra network. Because of its topology, the Ispra campus requires advanced fibre optic backbone facilities, bridges between LANs and powerful gateways to the external world. A special effort is being devoted to the network management aspects and the elimination of bottlenecks caused by technical incompatibilities and different operational practices.

- value added services and distributed system management. Networked office and scientific workstations refer to common E-mail, file transfer, archiving and backup servers. The rapid evolution of technology requires a continuous coordination of roles and responsibilities between local initiatives and shared services. The possibility for an important reduction of the overall human resources devoted to support activities would emerge from an enhanced standardisation of hardware platforms, basic software tools and user interfaces. Intensive technical discussions and market surveys have been activated for the purpose.
- information systems. The capillary introduction of client/server approaches is expected to help the overall JRC process towards decentralisation of functions and responsibilities. Whereas the common administrative workflows and procedures require adaptation to the new financial regulations and practices, new demands are emerging for computer supported planning, project monitoring, and evaluation. Advanced groupware products might be deployed and this is, to a large extent, a rather unexplored area for support activities.
- education, training and customer support. Both internal and external initiatives will contribute to the creation of the customer of the future. In particular, a coordinated set of educational initiatives and a friendly and comprehensive user help-desk function will enhance user satisfaction and efficiency.

In order to prepare for the underlying change in the services, the Informatics Services personnel are carrying out a number of feasibility studies aimed at the definition of new organisational and technical measures to be adopted in the support of the various components of our informatics infrastructure.

The most challenging projects are: JRC 64kbps network, new MVS administrative server, scientific user migration to departmental systems, common base platform definition for workstation interoperability and standardisation of vertical applications, well managed E- mail based on X400 and introduction of X500 directory service, networked file/archive/print

servers, distributed systems management, database server acting as information repository, new information systems in support of scientific management, general help desk and customer support, education and training plans.

This brainstorming effort is carried out in parallel with the normal service activities and developments previously decided. During 1991, important achievements can be reported in several areas:

- the mainframe MVS and UTS system has been provided with a fully automated backup and restore-on-demand feature accessible across the campus network. New version of compilers and transaction monitors have contributed to an increased serviceability and performance of the system.

- the SYSCCR financial and accounting system has been re-engineered according to the new accounting method and taking into account the decentralisation of the financial management consistent with the Institute structure. A major effort was put into the production of high quality documentation, made essential by the growing number of regular and occasional users. The integration of the management of contracts is under development.

- the 60th building was connected to the Ispra 100 Mbps fibre optic backbone network. This network is the primary catalyst in the growth of the office automation network based on the use of heteroge-

neous platforms and the proliferation of scientific workstations and servers.

- the connectivity to the external world is now provided by 6*9.6 Kbps lines to the Italian ITAPAC PSN, 1*64 Kbps line to the IXI European R/D network and 1*9.6 Kbps line to a private VAN service.

- the E-mail post office service originally based on proprietary message systems and SMTP gateways is rapidly evolving towards an integrated environment of X400 domains. First experiments with standard document interchange formats are carried out between the various computing platforms currently in use.

The Informatics Services are clearly involved in activities related to development of new services, analysis of existing services, analysis of market trends and analysis of customer requirements. In some cases this work is performed by internal staff in collaboration with university students performing projects as dissertation of thesis work. These activities were centred around the following areas: wide network security and distributed resources authorisation, computer-based tools to assist information flows in an organisation (bulletin boards and conferences), algorithms for the optimisation of file migration strategies (large hierarchical mass storage systems). This type of project activity has proved to be extremely fruitful both for the students and for the service.

10 ANNEXES

10 ANNEXES

LIST OF PUBLICATIONS

Protection of the Environment

CONTRIBUTIONS TO PERIODICALS AND MONOGRAPHS

ARGENTESI, F., PARUCCINI, M., DI COLA, G. - Sistemi Cognitivi per lo Studio dei Problemi Ambientali. In: Atti del Convegno "Sistemi Informativi per l'Ambiente. Realtà e Prospettive", 22-24 giugno 1989, Lerici (I) - ART 29947

CONTRIBUTIONS TO CONFERENCES

GABRIC, A., KOHL, M., REALINI, G. - MECOM, an Object-Oriented Approach to Marine Ecosystem Modelling. 3rd Intern. Software Exhibition for Environmental Science and Engineering, CRTA, 18-19 October 1991, Como (I), Guida di Informatica Ambientale (1991) 149-153 - ORA/ART 36416

MURRAY, N., GABRIC, A., REALINI, G., KOHL, M. - The Production and Cycling of Dimethylsulphide in Marine Waters. A Simulation Approach. Environmental Pollution and its Impact on Life in the Mediterranean Region, MESAEP, 6-9 October 1991, Como (I) - ORA 36445

Industrial Hazards

CONTRIBUTION TO PERIODICALS AND MONOGRAPHS

FUNTOWICZ, S., RAVETZ, J. - The Emergence of Post-Normal Science. Ecological Physical Chemistry. In: Proceedings of an International Workshop, Siena, Italy, 8-12 November 1990, Elsevier Sci. Publ., Amsterdam (NL) - ART 29881

FUNTOWICZ, S., RAVETZ, J. - A New Scientific Methodology for Global Environmental Issues. In: Ecological Economics: The Science and Management of Sustainability, Columnia, U.P., New York, R. Costanza (Ed.) - ART 29928

CACCIABUE, P., COJAZZI, G. - Using MMI Simulation for Improving Human Reliability and Operator's Ability to Run Complex Systems, Control of Safety J. Whiley Publ., B. Brehmer, J. Reason (Eds.) ART 40078

DE MARCHI, B. - La Sociologia dei Disastri. Teorie ed Esperienze. In: Quaderno di Ecologia Umana, Univ. Padova, G. Righetto (Ed.) - ART 40371

FUNTOWICZ, S., RAVETZ, J. - Global Risk, Uncertainty and Ignorance. In: Global Environmental Risk, UNU, J.X. Kasperson and R.E. Kasperson (Eds.), Section B, Chapter 3 - ART 40372

HAASTRUP, P., BROCKHOFF, L. - Reliability of Accident Case Histories Concerning Hazardous Chemicals. An Analysis of Uncertainty and Quality Aspects. Journal of Hazardous Materials, Vol. 27 (1991) 339-350 - ART 29813

AMENDOLA, A., CONTINI, S., ZIOMAS, I. - Uncertainties in Chemical Risk Assessment. Results of a European Benchmark Exercise. Journal of Hazardous Materials, Vol. 29 (1992) 347-363 - ART 29882

FUNTOWICZ, S., RAVETZ, J. - Problemi Ambientali Globali e Scienza Postnormale. OIKOS, Vol. 3 (1991) 103-123 - ART 29927

FUNTOWICZ, S., TIEZZI, E. - Editoriale. OIKOS, Vol. 3 (1991) 9-11 - ART 29929

DE MARCHI, B. - Public Information about Major Accident Hazards: Legal Requirements and Practical Implementation. Industrial Crisis Quarterly, Vol. 5 (1991) 239-251 - ART 29988

DE MARCHI, B. - Effective Communication between the Scientific Community and the Media. Disasters. The Journal of Disaster Studies and Management, Vol. 15, No. 3 (1991) 237-243 - ART 40028

HAASTRUP, P., RASMUSSEN, K., BROCKHOFF, L. - Miljoe og Humane Effekter ved Uheld med Farlige Stoffer. Pilotundersoegelse af Uheld i Frankrig 1987-1989. Dansk Kemi, Vol. 72 (1991) 396-400 - ART 40094

COSTANZA, R., FUNTOWICZ, S., RAVETZ, J. - Assessing and Communicating Data Quality in Policy Relevant Research. Environmental Management, Vol. 16, No. 1 (1992) 121-131 - ART 40097

FUNTOWICZ, S., RAVETZ, J. - Risk Management as a Post-Normal Science. Risk Analysis, Vol. 12, No. 1 (1992) 95-97 - ART 40107

DE MARCHI, B., FUNTOWICZ, S. - Decidere nell'Incertezza. Sistema Ricerca, No. 22 (1991) 18-23 - ART 40121

TECHNICAL EUR REPORTS

CONTINI, S., AMENDOLA, A., ZIOMAS, I. - Benchmark Exercise on Major Hazard Analysis. Vol. 1. Description of the Project, Discussion of the Results and Conclusions - EUR 13386/EN (1991)

CONTINI, S. - Benchmark Exercise on Major Hazard Analysis. Vol. 2. Part 1. Summary Contributions of Participants - EUR 13597/I/EN (1991)

CONTINI, S. - Benchmark Exercise on Major Hazard Analysis. Vol. 2. Part 2. Summary Contributions of Participants - EUR 13597/II/EN (1991)

CACCIABUE, P., DECORTIS, F., DROZDOWICZ, B., MASSON, M., NORDVIK, J. - COSIMO, a Cognitive Simulation Model of Human Decision Making and Beha-

viour in Complex Work Environments - EUR 13805/EN (1991)

GADOMSKA, M. - Social Decision Making in Environmental Impact Management. Some Sociological and Technological Questions - EUR 13809/EN (1991)

CONTINI, S. - ISPRA-FTA, Interactive Software Package for Reliability Analysis. Fault Tree Analysis Tool for Personal Computers. Methodological Aspects and User Interface Description - EUR 13997/EN (1991)

PARUCCINI, M. - Decision Support Systems for Environmental Management - EUR 14087/EN (1991)

FLAMM, J., LUISI, T. (Eds.) - Reliability Data Collection and Analysis. Proceedings of an EUROCOURSE, 8-12 October 1990, Ispra (I), Kluwer Acadmic Publ. - EUR 14205/EN (1991)

COLOMBO, A.G. (Ed.) - Environmental Impact Assessment. Proceedings of an EUROCOURSE, 30 Sept. - 4 October 1991, Ispra (I), Kluwer Academic Publ. - EUR 14206/EN (1991)

COLOMBO, A.G., MALCEVSKI, S., ZAMBRINI, M. (Eds.) - Atti del Workshop "Standard Ambientali", Ispra, 2 dicembre 1991 - EUR 14207/IT (1991)

GOW, H. (Ed.) - Proceedings of EUROPALIA '89 on "Perception of Risk in Human Activities", 12-13 October 1989, Elsevier Science Pub l., H.B.F. Gow (Ed.) - EUR 13582/EN (1991)

CONTRIBUTIONS TO CONFERENCES

CONTINI, S., AMENDOLA, A., ZIOMAS, I. - Uncertainties in Chemical Risk Assessment. Lessons Learnt from a European Benchmark Exercise . In: Proceedings of the Probabilistic Safety Assessment and Management (PSAM), SRA, 4-7 February 1991, Beverly Hills, CA (USA) Elsevier Publ., G. Apostolakis (Ed.) - ORA/PRO 35693

AGLIARI, A., CALVI PARISETTI, C., OLIVI, L., PESARIN , F. - Combination of Several Expert Information Sources in the Context of Linear Models. In: Proceedings of the Conference on Bayesian Statistics, State Government Valencia, 15-20 April 1991, Peniscola (E) - ORA 35992

HAASTRUP, P., BROCKHOFF, L. - Review of Transportation Accidents of Hazardous Materials. In: Proceedings of the Conferences on Hazardous Substances: Safety in Transport, ISA, 10-12 June 1991, Frankfurt/M. (D) - ORA/PRO 36178

POUCET, A., NORDVIK, J., MITCHISON, N. - Knowledge-Based Systems and Machine Learning for Enhancing Plant Safety. In: Proceedings of the 13th World Congress on Computation and Applied Mathematics, IMACS, 22-26 July 1991, Dublin (IRL) - ORA/PRO 36239

LESSI, O., OLIVI, L., PARISI, P. - Handbook of Process Diagnostic. Diagnostic for Industrial Processes in a Context of Dynamic Linear Models. In: Proceedings of the Conference " La Statistica nella Gestione Aziendale e nelle Analisi di Mercato", Univ. Padova, 18- 19 September 1991, Bressanone (I) - ORA/PRO 36337

BURBELLO, F., POLLARD, S., PORRILL, J., MAYHEW, J. - Retrieval of High-Level Data Structures from Stereo Vision Data. In: Proceedings of the Secondo Congresso dell'Associazione Italiana per l'Intelligenza Artificiale, 28-31 October 1991, Palermo (I) - ORA/PRO 3634 1

DE MARCHI, B. - Comunicazione e Accettabilità del Rischio. In: Atti della Conferenza sui Rapporti di Sicurezza nella CEE, 3ASI, 18 -19 settembre 1991, Milano (I) - ORA/PRO 36360

DROGARIS, G. - Pollution Abatement in Oil Refineries and Inorganic Chemical Industries. In: Proceedings of the EUROCOURSE on Environmental Impact Assessment, CEC, 30 September - 4 October 1991, Ispra (I), Kluwer Acad. Publ., A.G. Colombo (Ed.) - ORA/PRO 36410

AMENDOLA, A., VOLTA, G. - Knowledge, Judgement and Uncertainty in Current Practices of Risk Analysis. In: Proceedings of the Third SRA Europe Conference, WHO, IAASA, INPS, 16-18 December 1991, Paris (F) - ORA/PRO 35645

MASERA, M., COLOMBO, A.G. - Content and Phases of an Environmental Impact Assessment Study. In: Proceedings of the EUROCOURSE on Environmental Impact Assessment, CEC, 30 September - 4 October 1991, Ispra (I), Kluwer Acad. Publ., A.G. Colombo (Ed.) - ORA/PRO 3656 1

COLOMBO, A.G. - Sulla Scelta dei Parametri Statistici Usati come Riferimento negli Standard Ambientali. In: Atti del Workshop "Standard Ambientali", CEC-ISEI, 2 dicembre 1991, Ispra (I) - ORA/PRO 36563

VOLTA, G. - Metodi per la Valutazione della Sicurezza di Impianti ad Automazione Integrale. Giornata di Studio "Evoluzione del Trasporto di Massa verso l'Automazione Integrale", Politecnico Milano, 4-5 luglio 1991, Milano (I) - ORA 36329

ZENIE', A., VOLTA, G. - Writing a Document Using E-Mail in a Scientific Environment. Evaluation of a Simple Experiment. 2nd European Conference on Computer-Supported Cooperative Work, Univ. Amsterdam, 25-27 September 1991, Amsterdam (NL) - ORA 36406

MUNDA, G., NIJKAMP, P., RIETVELD, P. - Fuzzy Set and Cluster Analysis in Qualitative Multicriteria Evaluation. XV Convegno Annuale, AMASES, Univ. Trieste, 26-29 September 1991, Grado (I) - ORA 36407

MUNDA, G. - Multicriteria Evaluation Methods in Economic-Environmental Modelling. Autumn Workshop in Environmental Economics, 29 September - 5 October 1991, Venezia (I) - ORA 36409

FUNTOWICZ, S. - Post-Normal Science: A New Epistemology for Global Issues. First Intern. Conference of the EABS "Entropy and Bioeconomics", 28-30 November 1991, Roma (I) - ORA 36532

DE MARCHI, B., FUNTOWICZ, S. - Interdipendenza Ambientale e Diffusione delle Catastrofi. Europa, Innovazioni Tecnologiche e Salvaguardia delle Catastrofi

Ambientali, ISI, 12-14 dicembre 1991, Gorizia (I) - ORA 36533

PARUCCINI, M. - Sistemi di Supporto alla Decisione per lo Gestione del Territorio. Europa, Innovazioni Tecnologiche e Salvoguardio delle Catostrofi Ambientoli, ISI, 12-14 dicembre 1991, Gorizia (I) - ORA 36534

TECHNICAL NOTES

GOW, H. - Summory of the 7th Meeting of the CEDB Steering Committee - T.N./I.91.03

ROEBBELEN, D. - WRITED ond READED, a Program System to Transfer Data Files from VAX/VMS to SUN Databases - T.N./I.91.39

DE MARCHI, B. - Public Information about Major Accident Hazards: Legol Requirements ond Practical Implementation - T.N./I.91.50

DE MARCHI, B. - Effective Communication between the Scientific Community and the Media - T.N./I.91.51

MASERA, M. - The SKEW Project - T.N./I.91.53

HAASTRUP, P., RASMUSSEN, K., BROCKHOFF, L. - Environmentol and Human Consequences of Accidents with Hazardous Chemicals. A Pilot Investigation of Accidents in France 1987-1989 - T.N./I.91.64

KOURNETA, P. - DOMINO Effects in Accident Consequence Analysis. Description of the DOMINO Computer Program and Future Developments - T.N./I.91.68

DI MARCHI, B. - Direttiva Seveso e Informazione ol Publico - T.N./I.91.73

PECKHAM, R. - Geographical Information in the JRC - T.N./I.91.88

BROCKHOFF, L. - XTRIM, Version 1.0. Documentation, Version 1.0. A Computer Based Decision Support System for Transportation Risk Management - T.N./I.91.89

DE MARCHI, B., FUNTOWICZ, S. - Rapporto sullo Stato di Attuazione dell'Art. 8 della Direttiva Seveso (82/501/CEE) - T.N./I.91.126

DE MARCHI, B. - La Sociologia dei Disastri. Teoria ed Esperienze - T.N./I.91.127

PRATI, N. - Triangular Conorms and Fuzzy Sets for the Treatment of Quality Indices - T.N./I.91.134

BEST, C., ROEBBELEN, D. - SPLASH, a PV-Wave Application Interfaced Directly to the EDF Database - T.N./I.91.143

SCHNEIDER, J., RICHARD, N., PAPADOPOULOS, S., CRUTZEN, Y. - Preliminary Investigation on Eddy-Current Heat Deposition during Plasma Disruptions - T.N./I.91.156

SPECIAL PUBLICATIONS

FLAMM, J., POUCET, A. (Eds.) - First ESReDA Seminar on "The Use of Expert Systems in Safety Assessment and Management" - S.P./I.91.3 1

Reference Methods for Structural Reliability

CONTRIBUTIONS TO CONFERENCES

DUFRESNE, J., LUCIA, A. - Assessment of the Residual Lifetime of Reactor Pressure Vessels. In: Proceedings of the 11th SMiRT Conference, JAERI, 18 - 23 August 1991, Tokyo (Japan) - ORA/PRO 35996

LUCIA, A., VOLTA, G. - A Knowledge Based System for Structural Reliability Assessment. In: Proceedings of the 11th SMiRT Conference, JAERI, 18-23 August 1991, Tokyo (Japan) - ORA/PRO 35997

KHONG, V., LUCIA, A. - RAMINO, o Knowledge Based System ond a Coordinotor of Numericol Models for Structural Reliability Assessment. In: Proceedings of the Safety and Reliability Symposium (OMAE-91), ASME-NIF, 23-28 June 1991, Stavanger (N) - ORA/PRO 36194

LUCIA, A., MELVIN, A. - Non-Destructive Evaluation of Composite Materials. 2. The Thermal Response to Deformation of Lominotes. In: Lecture Notes of the Introductory Workshop on Composite Materials, ICS, 28 October - 8 November 1991, Trieste (I) - ORA/PRO 36514

SOLOMOS, G., LUCIA, A. - Non-Destructive Evaluations of Composite Moterials. 1. Delamination Detection via Holographic Interferometry. In: Lecture Notes of the Introductory Workshop on Composite Materials, ICS, 28 October - 8 November 1991, Trieste (I) - ORA/PRO 3 6515

DIPLA, A., OLIVARI, D. - An Attempt to Describe the Fractal Choracteristics of the Concentration Field of a Scalar Dispersed by a Turbulent Flow Field. Miniworkshop on Linearity: Fractals, Pattern Formation, Intern. Centre for Theoretical Physics, 11 June - 6 July 1991, Trieste (I) - ORA/POST 36325

TECHNICAL NOTES

SOLOMOS, G., ZANETTA, P., FACCHINI, M. - Vibration Studies. Using Laser Holographic Interferometry - T.N./I.91.148

Reference Methods for Non-Nuclear Energies

CONTRIBUTIONS TO PERIODICALS AND MONOGRAPHS

CONTI, F., HELCKE, G., ETO, J. - Metodi di Stimo dei Costi Sociali-Ambientoli della Produzione di Energio Elettrica. Energia, Vol. 2 (1991) 12-26 - ART 40218

TECHNICAL EUR REPORTS

MORRISON, G., GILLIAERT, D., TEBALDI, P. - ISO Solar Thermal Standards. Studies to Improve Technical and Scientific Information for the Finalization of Performance Test Procedures - EUR 13469/EN (1991)

BLOEM, J. (Ed.) - Proceedings of the Workshop on Advanced Identification Tools in Solar Energy Research, 5-7 November 1990, Ispra (I) - EUR 13470/EN (1991)

OSSENBRINK, H., ROSSI, E. - Qualification Test Procedures for Crystalline Silicon Photovoltaic Modules - EUR 13897/EN (1991)

COLOMBO, R., GILLIAERT, D. - Analisi Termoigrometrica di una Parete. Procedura Computerizzata: GLASERG - EUR 13904/IT (1991)

COLOMBO, R., GILLIAERT, D. - Dimensionamento di un Impianto Solare per la Produzione di Acqua Calda per Usi Sanitari - EUR 13905/IT (1991)

CONTRIBUTIONS TO CONFERENCES

GILLIAERT, D., TEBALDI, P. - Impianti Solari per il Riscaldamento di Acqua Sanitaria. In: Atti del Meeting Architettura Bioclimatica, Collegio dei Geometri, 7 maggio 1991, Varese (I) - ORA/PRO 36345

BLOEM, J. - PASSYS Testsite Inspection Visits. PASSYS TSM Meeting, CRES, 9-10 October 1991, Athens (GR) - ORA 36543

LEBOEUF, C., OSSENBRINK, H.- PV Module Power Output: Sensitivity and Uncertainty in Non-STC Measurements. 23rd PV Specialists Conference, IEEE, 7-11 October 1991, Las Vegas, Nev. (USA) - ORA 36562

PAFELIAS, T., GILLIAERT, D. - Telemonitoring Techniques for Solar Thermal Installations in Hotels in Greece, its European Dimension and Interaction. Solarhotel, CEC-DG XVII, 13-16 November 1991, Palma de Mallorca (E) - ORA 36579

GILLIAERT, D. - Solar Active Systems. Another Energy Source of the 1990's. Solarhotel, CEC-DG XVII 13-16 November 1991, Palma de Mallorca (E) - ORA 36580

TECHNICAL NOTES

BISHOP, J., ROSSI, E., BRAMBILLA, E., DAL BON, G., RAU, P.,- Photovoltaic Module Test Report PV-MT-90-FL - T.N./I.91.27

MARTINO, R., VAN STEENWINKEL, R. - The Numerical Simulation of Crystalline Silicon Solar Cells. The Steady-State Behaviour - T.N./I. 91.36

BISHOP, J., ROSSI, E., BRAMBILLA, E., RAU, P., BAUER, E. - Photovoltaic Module Test Report PV-MT-90-YE - T.N./I.91.99

BISHOP, J., BAUER, E., BRAMBILLA, E., DAL BON, G., RAU, P. - Photovoltaic Module Test Report PV-MT-91-HQ - T.N./I.91.103

BISHOP, J., BRAMBILLA, E., DAL BON, G., RAU, P. - Photovoltaic Module Test Report PV-MT-91-YF - T.N./I.91.104

BISHOP, J., BRAMBILLA, E., DAL BON, G., RAU, P. - Photovoltaic Module Test Report PV-MT-91-OO - T.N./I.91.105

BISHOP, J., BAUER, E., BRAMBILLA, E., DAL BON, G., RAU, P. - Photovoltaic Module Test Report PV-MT-91-OQ - T.N./I.91.106

TOURNIER, A. - XEVAL, an X-Window Application Designed for Evaluation of Photovoltaic Data Monitoring - T.N./I.91.107

BLAESSER, G., ZAAIMAN, W. - Power Measurements at the Photovoltaic Plant Los Arcos (Murcia, Spain) - T.N./I.91.123

BLAESSER, G., ZAAIMAN, W. - Power Measurements at the Photovoltaic Plant Tabarca (Alicante, Spain) - T.N./I.91.124

TOURNIER, A., ZAAIMAN, W., BLAESSER, G. - Power Measurements at the Photovoltaic Plant Giubiasco - T.N./I.91.139

BISHOP, J. - Performance at STC - Kyocera LA361J48 Modules - T.N./I.91.146

BISHOP, J. - Performance at STC Measurements. Photowatt BPX47500 Modules - T.N./I.91.149

BISHOP, J. - Automatic Report Generation under UNIX with AWK, Shell Script and Framemaker - T.N./I.91.150

LEBOEUF, C., OSSENBRINK, H. - PV Module Power Output: Sensitivity and Uncertainty in Non-STC Measurements - T.N./I.91.152

BISHOP, J., RAU, P., ZAAIMAN, W. - Performance Measurements. Helios Technology H100 Modules - T.N./I.91.159

SPECIAL PUBLICATIONS

GILLIAERT, D., QUINETTE, Y. - Installations Solaires Collectives de Production d'Eau Chaude Sanitaire. Garantie de Résultats - S.P. /I.91.30

COLOMBO, R., GILLIAERT, D. - Telemonitoring and Qualitative Evaluation of "THERMIE" Solar Thermal Projects - S.P./I.91.32

Reactor Safety

CONTRIBUTIONS TO PERIODICALS AND MONOGRAPHS

BESI, A. - EuReDatA Benchmark Exercise on Data Analysis. Proceedings of the EUROCOURSE "Reliability Data Collection and Analysis", 8 -12 October 1990, Ispra, Italy, Kluwer Acad. Publ., T. Luisi (Ed.) - ART 40024

TECHNICAL EUR REPORTS

LEGER, L. - Applications des Méthodes de Projection Pursuit à l'Estimation Fonctionnelle - EUR 13382/FR (1991)

LEGER, L. - Etude d'un Estimateur à Noyau de la Fonction de Hasard - EUR 13468/FR (1991)

BOCKHOLTS, P., KOEHORST, L., LUISI, T. - EuReDatA - Project Report No. 6. Characteristics of Incident Databases for Risk Assessment - EUR 14221/EN (1991)

CONTRIBUTIONS TO CONFERENCES

MAGNARA, S., DI MARTINO, C., LISANTI, B.*, MAN-
CINI, G., RIZZO, A.* - A Human Error Taxonomy Based
on Cognitive Engineering and on Social and Occupatio-
nal Psychology. In: Proceedings of the Conference on Pro-
babilistic Safety Assessment and Management (PSAM),
SRA, 4 -7 February 1991, Beverly Hills, CA. (USA), Else-
vier Publ., G. Apostolakis (Ed.) - ORA/PRO 35602

CALVI PARISETTI, C., OLIVI, L., PESARIN, F. - Pooling of
Multi-Source Information in a Decision Process. In: Procee-
dings of the Conference on Probabilistic Safety Assessment
and Management (PSAM), SRA, 4-7 February 1991,
Beverly Hills, CA. (USA), Elsevier Publ., G. Apostolakis
(Ed.) - ORA/PRO 35603

CACCIABUE, P., CARPIGNANO, A., COJAZZI, G. -
Dynamic Reliability Analysis by DYLAM Methodology. The
Case of the CVCS of a PWR. In: Proceedings of the Con-
ference on Probabilistic Safety Assessment and Manage-
ment (PSAM), SRA, 4-7 February 1991, Beverly Hills, CA.
(U SA), Elsevier Publ., G. Apostolakis (Ed.) - ORA/PRO
35604

CACCIABUE, P., VIVALDA, A. - A Logical Methodology
for Evaluating Dynamic Human Error Probabilities. In: Pro-
ceedings of the Conference on Probabilistic Safety Asses-
sment and Management (PSAM), SRA, 4-7 February
1991, Beverly Hills, CA. (USA), Elsevier Publ., G. Aposto-
lakis (Ed.) - ORA/PRO 35605

POUCET, A. - Interacting Expert Systems for Plant Safety
Analysis. In: Proceedings of the Conference on Probabili-
stic Safety Assessment and Management (PSAM), SRA, 4-7
February 1991, Beverly Hills, CA (USA), Elsevier Publ., G.
Apostolakis (Ed.) - ORA/PRO 35606

LESSI, O., OLIVI, L., PARISI, P. - Fault Detection and Dia-
gnosis in Linear Systems. In: Proceedings of SAFEPRO-
CESS '91, IFAC, 10-13 September 1991, Baden-Baden
(D) - ORA/PRO 35681

ANDRITSOS, F. - Thermal Transient of a Corium Pool and
its Containing Vessel. Boiling Water Reactor Lower Head
Failure. In: Proceedings of the 2nd National Congress of
the ABAQUS User's Group Italy, 21-22 March 1991,
Bologna (I) - ORA/PRO 35989

COJAZZI, G., LOCKETT, J., WEATLEY, K. - Training Simu-
lators as a Tool for Eliciting Plant Operators Knowledge.
The Winfrith Experiment. In: Proceedings of the Specialist
Meeting on Training Simulators for Safe Operation in
Nuclear Power Plants, IAEA, 24-27 September 1991,
Balatonfured (H) - ORA/PRO 36269

ANDRITSOS, F. - Thermal Stress Distribution in a Tubular
Test Specimen. In: Proceedings of the 2nd National Con-
gress of the ABAQUS User's Group Italy, 21-22 March
1991, Bologna (I) ORA/PRO - 35990

TECHNICAL NOTES

ANDRITSOS, F. - Thermal Stress Distribution in a Cylindri-
cal Test Specimen. Fafnir Project, Out of Pile -
T.N./I.91.01

ARSENIS, S. - On the Performance of Different Sets of
ELMOS in the CEDB with Particular Reference to ELMOS.
Part I. Data Validation and Stratification via "Intelligent
Selections" - T.N./I.91.34

ARSENIS, S. - On the Performance of Different Sets of
ELMOS in the CEDB with Particular Reference to ENEL
ELMOS. Part II. Testing for Heterogeneities of Classical
Estimates of Failure Rates within Component Strata -
T.N./I.91.44

DECORTIS, F., BELLORINI, A., KJAER-HANSEN, J.,
COJAZZI, G., DROSDOWICZ. B.* - Knowledge Elicita-
tion of Operators Working on a Steam Generating Heavy
Water Reactor Simulator. Preliminary Results and Integra-
tion in COSIMO - T.N./I.91.57

KONT, S. - Analyse de Défaillance dans les Processus
Complexes. Etude d'un Système de Diagnostic de Panne -
T.N./I.91.60

BALESTRERI, S. - Summary of the 8th Meeting of the CEDB
Steering Committee, held at NUCLENOR in Santander,
Spain, on 13-14 May 1991 - T.N./I.91.81

ARSENIS, S. - Assessment of Performance of ENEL ELMOs
vs Other ELMOs in CEDB. Testing for Heterogeneities of
Component Failure Rates in the Classical Framework -
T.N./I.91.112

COJAZZI, G., LOCKETT, J., WHEATLEY, K. - Training
Simulators as a Tool for Eliciting Plant Operators Know-
ledge: the Winfrith Experiment - T.N./I.91.128

BALESTRERI, S. - EIREDA, European Industry Reliability Data
Handbook. Vol. 1. Electrical Power Plants -
T.N./I.91.131

Safeguards and Fissile Material Management

TECHNICAL EUR REPORTS
STANCHI, L.(Ed.) - Proceedings of the 13th ESARDA Sym-
posium on Safeguards and Nuclear Material Management
- EUR 13686/EN (1991)

CONTRIBUTIONS TO CONFERENCES
GONCALVES, J., SOREL, F., VEIGA, P. - A Man-Machine
Interface for a Teleoperated Vehicle. In: Proceedings of
MELECON '91, IEEE, 22-2 4 May 1991, Ljubljana (YU) -
ORA/PRO 35993

GONCALVES, J., VEIGA, P., CAMPOS, G., PERDIGAO,
J., SOREL, F. - Navigation of a Tele-Operated Vehicle in a
Safeguards Environment. In: Proceedings of the 13th
Annual Symposium on Safeguards and Nuclear Material
Management, ESARDA, 14-16 May 1991, Avignon (F), L.
Stanchi (Ed.), EUR 13686/EN (1991) 549-553 -
ORA/PRO 36181

CUYPERS, M., DWORSCHAK, H., GUARDINI, S.,
HUNT, B., LANDAT, D. - Test and Training Facilities at the

Joint Research Centre, Ispra, for Safeguards Inspectors. In: Proceedings of the 32nd Annual Meeting of the Institute of Nuclear Materials Management, 28-31 July 1991, New Orleans. La. (USA) - ORA/PRO 36268

CAJSSE D'AGRAIVES, B., LINGE, A., MASCETTI, E., TOORNVLIET. J., GOURLEZ, P., DE JONG, P., CHERON, P. - Tapping of Spent Fuel Transport Casks. In: Proceedings of the 32nd Annual Meeting of the Institute of Nuclear Materials Management, 28-31 July 1991, New Orleans. La. (USA) - ORA/PRO 36332

TECHNICAL NOTES

FOGGI. C. - CALDEX. 2. Effects of Temperature and Water Evaporation. A Theoretical Analysis - T.N./I.91.10

FOGGI, C. - Esperienza CALDEX. 1. Acquisizione e Condizionamento Dati - T.N./I.91.11

KORN, C. - Fiabilité Mécanique des Sceaux-Boulons MARK-4-R - T.N./I.91.18

LINGE, A. - Interchangeabilité des Systèmes de Lecture de Sceaux Mark-4-R - T.N./I.91.62

KORN, C. - Influence de la Rugosité sur une Lecture de Surface par Laser Monopoint - T.N./I.91.72

LINGE, A. - Sealing-Bolts Identification. User's Manual - T.N./I.91.75

BETTENDROFFER, E., COLZANI, S., MOL, M. - CAVIS 2, Computer Video Surveillance System. User Manual - T.N./I.91.90

MOL, M. - CAVIS 2, Computer Aided Video Surveillance System. Software Reference Manual, Vol. I - T.N./I.91.91/I

MOL, M. - CAVIS 2, Computer Aided Video Surveillance System. Software Reference Manual, Vol. II - T.N./I.91.91/II

LINGE, A. - Interchangeabilité des Systèmes de Lecture de Sceaux MARK-4-R (Version II) - T.N./I.91.113

LINGE, A. - Sealing-Bolts Identification User's Manual (Version II) - T.N./I.91.115

KORN, C. - Identités à Base de Résine Lues par Ultrasons. Première Approche - T.N./I.91.116

SANTOS, V. - Some Notes of the Master Mode of the AT-Bus - T.N./I.91.132

KORN, C., LINGE, A., MASCETTI, E., CAUSSE D'AGRAIVES, B. - Développement d'un Système Portable d'Identification par Lecture de Surface - T.N./I.91.151

Fusion Technology and Safety

CONTRIBUTIONS TO PERIODICALS AND MONOGRAPHS

YOUTSOS, A., BIGGIO, M., CRUTZEN, Y., FARFALETTI CASALI, F. - Instability Analysis of First Wall Components of a Tokamak Reactor Subjected to Electromagnetic Transients. Nuclear Engineering and Design/Fusion, Vol. 13 (1991) 395-405 - ART 29074

ANDRITSOS, F., ZUCCHETTI, M. - Afterheat Transient in ITER after a Total Loss-of-Coolant Accident. Fusion Engineering and Design, Vo l. 15, No. 2 (1991) 85-194 - ART 29675

CASINI, G., SANNIER, J. - Research and Development on Liquid Pb-17Li Breeder in Europe. Journal of Nuclear Materials, Vol. 179-181 (1991) 47-52 - ART 29700

CASINI, G. - A Water Cooled Lithium Lead Breeding Blanket for a DEMO Fusion Reactor. Fusion Engineering and Design, Vol. 14, Nos. 3 &4 (1992) 353-373 - ART 29879

TECHNICAL EUR REPORTS

BECQUET, M. - Teleoperation: Numerical Simulation and Experimental Validation. EUROCOURSE, Ispra, 18-22 November 1991 - EUR 14033/E N (1991)

COCCORESE, E., CRUTZEN, Y., ALBANESE, R. MOFINO,P.(Eds.) - Proceedings of the International TEAM Workshop Sorrento, 12-13 July 1991 - EUR 14173/EN (1991)

CONTRIBUTIONS TO CONFERENCES

ANDRITSOS, F., ZUCCHETTI, M. - Afterheat in Fusion Structural Materials and Thermal Transient Scenarios in ITER. 2nd Intern. Symposium on Fusion Nuclear Technology, KfK, 2-7 June 1991, Karlsruhe (D), Fusion Engineering and Design ORA/ART 35958

PONTI, C., ROCCO, P., ZUCCHETTI, M. - The Analysis of Neutron-Induced Transmutation and Activation in Nuclear Materials. Intern. Co ference on Physics of Irradiation Effects in Metal, Hungarian Ministry of Culture and Education, 20-24 May 1991, Siofok (H), Materials Science Forum 1991, Special Issue - ORA/ART 36183

MIYA, K., CRUTZEN, Y., TAKAGI, T., BOTTURA, L., BOCCACINI, L.* - Electromagnetic Effects on First Wall and Structural Components. ISFNT-2, KfK, 2-7 June 1991, Karlsruhe (D), Fusion Engineering and Design - ORA/ART 36223

CRUTZEN, Y., FARFALETTI CASALI, F. - Structural Design Aspects of the Locking System Needed for the Next Tokamak Plasma-Facing Components against Electromagnetic Transients. ISFNT-2, KfK 2-7 June 1991, Karlsruhe (D), Fusion Engineering and Design - ORA/ART 36224

CRUTZEN, Y., PAPADOPOULOS, S., SIAKAVELLAS, N. - 3D Codes Integrated Design/Analysis System Application in Transient Magneto-Structural Analysis. In: Proceedings of the 2nd ABAQUS National Congress, ABAGROUP, ENEA, 21-22 March 1991, Bologna (I) - ORA/PRO 36064

ROCCO, P., ZUCCHETTI, M. - Criteria for Low Activation Materials for Fusion Applications. In: Proceedings of the Workshop on Low Activation Materials, IAEA, 8 12 April

1991, Culham (UK). Implementation Agreement for a Programme of Research and IEA Paris, EUR FU B RU/12-6/91-MATIA 15 Development on Radiation Damage in Fusion Materials - ORA/PRO 36062

CRUTZEN, Y., PAPADOPOULOS, S., RICHARD, N., SIAKAVELLAS, N.*, WU, J.* - Recent Developments in Transient Magneto-Structural Integrat ed Analysis. In: Proceedings of the COMPUMAG Conference, 7-11 July 1991, Sorrento (I) - ORA/PRO 36234

BECQUET, M., FARFALETTI CASALI, F. - Remote Maintenance and Assembly of Fusion Reactors. In: Proceedings of the 11th SMiRT Conference, AISMiRT, JAES, 18-23 August 1991, Tokyo (Japan) - ORA/PRO 36244

ANGELINI, A., COPPI, B., NASSI, M. - Compact Ignition Experiments: Design and Performance. IEEE Symposium on Fusion Engineering, General Atomics, 30 September - 3 October 1991, San Diego, Cal. (USA) - ORA/PRO 36250

ROCCO, P., ZUCCHETTI, M. - New Low-Activation Criteria for Fusion Reactor Materials. In: Proceedings of the Annual Meeting of the American Nuclear Society, ANS, 2-6 June 1991, Orlando, Fla. (USA), Transactions of the American Nuclear Society, Macke (Ed.), Vol. 63 (1991) 105-106 -ORA/PRO 36275

ROCCO, P., ZUCCHETTI, M. - Silicon Carbide and the New Activation Requirements for a Fusion Reactor First Wall. In: Proceedings of the Fifth Intern. Conference on Fusion Reactor Materials, ORNL, 17-22 November 1991, Clearwater, Fla. (USA) - ORA/PRO 36343

BECQUET, M. - Reliability Improvement of Robotics Systems. Analysis, Design and Real Time Supervision. In: Proceedings of the Workshop on Safety Implications of Plant Automation and Robotics, IAEA, 11-15 November 1991, Wien (A) - ORA/PRO 36494

CASINI, G., ROCCO, P., ZUCCHETTI, M. - Radioactivity Effects of Pb-17Li in Fusion Power Reactors. 2nd Intern. Symposium on Fusion Nuclear Technology (ISFNT-2), KfK, 2-7 June 1991, Karlsruhe (D), Fusion Engineering and Design, Vol. 17 (1991) 351-357 - ORA/ART 36170

RICHARD, N., PAPADOPOULOS, S., CRUTZEN, Y. - Problem 12: Evaluation of the Magnetic Damping. Workshop on Testing of Electromagnetic Analysis Methods (TEAM), Univ. Napoli, 12-13 July 1991, Sorrento (I) - ORA 36279

TECHNICAL NOTES

BORGONOVI, M., INVERNIZZI, M., BECQUET, M. - MSconed-Algorithm to Convert Multi-Connected Bound-Rep Planar Polygons into Simply-Connected Ones - T.N./I.91.14

BORGONOVO, M., INVERNIZZI, M., BECQUET, M. - ConVX-Algorithm to Convert Simply Connected Bound-Rep Concave Planar Polygons into Sets of Convex Ones - T.N./I.91.15

WU, J., CRUTZEN, Y. - Eddy Currrents, Electromagnetic Body and Resultant Forces in the TOKAMAK Outboard

Blanket System during Plasma Disruption Events - T.N./I.91.16

CRUTZEN, Y., MIYAs, K., BOTTURA, L., BOCCACINI, L., TAKAGI, T. - Electromagnetic Effects on First Wall and Structural Components (Invited review contribution to ISFNT-2 Symposium, June 1991, Karlsruhe, Germany) - T.N./I.91.31

PAPADOPOULOS, S., SIAKAVELLAS, N. - Solution of Coupled Field-Structure Interactions in Presence of Crossed Magnetic Fields (Transient and Steady-State), Considering Small-Size Plate Specimens in Bending Mode - T.N./I.91.32

CAOURIS, Y. - The Code SIFNOS (vers. 1) for Loss-of-Vacuum Accident (LOVA) Analysis in Fusion Reactors with Air-Hot Graphite Interactions - T.N./I.91.35

ROCCO, P., ZUCCHETTI, M. - Short Term Radioactivity Aspects of the Li-Pb Eutectic as Fusion Breeding Material - T.N./I.91.40

ROCCO, P., CAOURIS, Y.* - Loss-of-Vacuum Accident (LOVA) in NET/ITER - T.N./I.91.46

BECQUET, M., CASTILLO, E., RUIZ, E., FARFALETTI CASALI , F. - State of the Art of Remote Assembly and Maintenance of Fusion Reactors - T.N./I.91.47

ANDRITSOS, F., ZUCCHETTI, M. - Sensitivity of ITER Post LOCA Transients to Various Structural Steels - T.N./I.91.48

ANDRITSOS, F. - Effects of the Thermal Boundary Conditions (Cryostat to the Post LOCA Transients of ITER) - T.N./I.91.56

RICHARD, N. - Développement de Pre- et Post-Processeurs de Code Magnétodynamique TRIFOU. Couplés à l'Outil Graphique PATRAN - T. N./I.91.61

ANDRITSOS, F. - Post LOCA Transient NET Design, Reinforced Concrete Cryostat - T.N./I.91.67

CALI', R., MARTINA. E. - Convalida di Segnali e Impiego di Logiche Qualitative di Controllo per la Diagnostica di Sistemi Complessi. Applicazione al Sistema di Controllo Chimico e Volumetrico di un Impianto PWR - T.N./I.91.86

SCHNEIDER, J. - Preliminary Modelling of the Halo Currents in Tokamak - T.N./I.91.94

RICHARD, N. - Manuel d'Utilisation du Code Magnéto-Dynamique TRIFOU sur VAX 8530 - T.N./I.91.114

CASINI, G., PETRIZZI, L., RADO, V., ZUCCHETTI. M. - Three-Dimensional Neutronic Analyses of a Water-Cooled Pb17Li Blanket for a Demo Reactor - T.N./I.91.122

ANDRITSOS, F. - Post LOCA Transient of the Outboard Region of ITER - T.N./I.91.137

ANDRITSOS. F. - Post LOCA Transient. ITER Reference Design, Steel Cryostat - T.N./I.91.141

ROCCO, P., CAOURIS, Y. - Loss-of-Vacuum Accidents (LOVAS) in NET/ITER. Final Report of the Sub-Task SEA 3-7 - T.N./I.91.144

ROCCO, P. - Fusion Long-Term Safety and Environmental Tasks (LTSE). Status and Summary Report 1989-1991 - T.N./I.91.145

RICHARD, N. - Activités Relatives au Code Magnétodynamique TRIFOU au Sein du Laboratoire TESLA - T.N./I.91.154

Support to the Commission

Energy Policy

TECHNICAL EUR REPORTS

CCLOMBO, R., GILLIAERT, D., LANDABASO, A. - Guidelines for the Technical Follow-up of Solar Thermal Plants - EUR 13518/EN (1991)

CCLOMBO, R., GILLIAERT, D., LANDABASO, A. - Life Cycle Cost Analysis of Solar Heating and DHW System in Res'dential Buildings - EUR 13581/EN (1991)

HELCKE, G., PECKHAM, R. - The Computation of Degree-Days for Use as a Climatic Severity Indicator in EUROSTAT Energy Statistical Tables - EUR 13697/EN (1991)

CONTRIBUTIONS TO CONFERENCES

CCLOMBO, R., GILLIAERT, D. - Telemonitoring and Qualitative Evaluation of "THERMIE" Solar Thermal Projects. 3rd Meeting of the European Working Group on Solar Thermal Plant Monitoring, CEC-JRC, 16-18 October 1991, Abingdon (UK). Also published in: S.P./I.91.32 - ORA 36577

Environment Policy

CONTRIBUTIONS TO PERIODICALS AND MONOGRAPHS

CCNTI, F., ETO, J. - Meccanismi di Mercato per l'Internalizzazione delle Diseconomie Ambientali. Energia, Vol. 3 (1991) 12-24 - ART 40243

TECHNICAL EUR REPORTS

DROGARIS, G. - Major Accident Reporting System. Lessons Learned from Accidents Notified (CDCIR 658-EAb5-IV.3) - EUR 13385/EN (1991)

HARRIS, S., ARREGGER, J., TRBOJEVIC, V., COX, R. - Comparison of LPG-Related Regulations - EUR 13699/EN (1991)

DROGARIS, G., SOLOMOS, G., AMENDOLA, A. - Benchmark Exercise on Major Hazard Analysis. Vol. 3. Seismic Analysis - EUR 13898/EN (1991)

LINDGAARD-JORGENS, P., BENDER, K. - Review of Environmental Accidents and Incidents - EUR 14002/EN (1991)

CONTRIBUTIONS TO CONFERENCES

AMENDOLA, A. - Major Hazards Regulation in the European Community. In: Proceedings of the Conference on Probabilistic Safety Assessment and Management (PSAM), SRA, 4-7 February 1991, Beverly Hills, Ca. (USA), Elsevier Publ., G. Apostolakis (Ed.) - ORA/PRO 35692

DROGARIS, G. - Major Accidents in Oil and Gas Industries. In: Proceedings of the First Intern. Conference on Health, Safety & Environment in Oil and Gas Exploration and Production, Soc. Petrol. Engin., 11-14 November 1991, Den Haag (NL) - ORA/PRO 36356

AMENDOLA, A., CONTINI, S. - Modalità di Esecuzione dei Rapporti di Sicurezza. In: Atti del VIII Convegno sui Rapporti di Sicurezza nella CEE, 3ASI, 18-19 settembre 1991, Milano (I) - ORA/PRO 36426

VAN DEN EEDE, G., VAN MONTAGU, M. - Applications of Genetically Modified Micro-Organisms in Agriculture. In: Proceedings of the 2nd Intern. Conference on the Release of Genetically Engineered Micro-Organisms, Univ. Nottingham, 29-31 August 1991, Nottingham (UK) - ORA/PRO 36485

AMENDOLA, A. - The EEC Directives on Environmental Hazards. In: Proceedings of the EUROCOURSE on "Environmental Impact Assessment", CEC, 30 September - 4 October 1991, Ispra (I), Kluwer Acad. Publ., A.G. Colombo (Ed.) - ORA/PRO 36487

AMENDOLA, A.- I Rischi per l'Uomo e l'Ambiente Dovuti agli Impianti Chimici (La Direttiva Seveso). L'Educazione al Rischio Ambientale, Univ. Verde, 20 marzo 1991, Caserta (I) - ORA 36091

DROGARIS, G., MUTZBAUER, G. - Lessons Learned from Major Accidents Causing Pollution. Environmental Pollution and its Impact in the Mediterranean Region, MESAEP, 6-9 October 1991, Como (I) - ORA 36414

AMENDOLA, A. - Piani d'Emergenza: Presupposti Tecnici, Problemi Aperti, Insegnamenti Tratti da Esperienze Concrete. Corso di Aggiornamento su Analisi dei Rischi nell'Industria di Processo, Politecnico Milano, 16 aprile 1991, Milano (I) - ORA 36093

AMENDOLA, A. - Preparedness and Response to Chemical Accidents. The Contribution of the CDCIR. Emergency Planning 91, Lancaster Univ., 8-11 September 1991, Loncaster (UK) - ORA 36283

TECHNICAL NOTES

AMIC, S. - Enregistrement et Vérification d'Images des Scelles à Metal sur Disque Optique Numérique - T.N./I.91.38

Environment Policy

TECHNICAL NOTES

DROGARIS, G. - Controlling Run-Away Reaction Hazards within the Framework of the Seveso-Directive - T.N./I.91.02

DROGARIS, G. - Hazards from Chemical Substances. Classification of Chemicals - T.N./I.91.65

COUTSOMITROS, E. - Legal Protection of Biotechnological Inventions - T.N./I.91.157

SPECIAL PUBLICATIONS

AMENDOLA, A., CONTINI, S. - National Approaches to the Safety Report. A Comparison - S.P./I.91.07

GOW, H. (Ed.) - Community Documentation Centre on Industrial Risk, Vol. 4 - S.P./I.91.09

GOW, H. (Ed.) - Community Documentation Centre on Industrial Risk Bulletin No. 5 - S.P./I.91.33

DROGARIS, G., MUELLER, G., MILES, A., MOCH, E. - Lessons Learned from Emergencies after Accidents in the Federal Republic of Germany Involving Dangerous Substances - S.P./I.91.23

AMENDOLA, A. - Land Use Planning with Respect to Major Accident Hazards. EUROCOURSE on "Loss Prevention and Risk Analysis in the Process Industry", CIEMAT, 22 June 1991, Madrid, Spain - S.P./I.91.17

AMENDOLA, A. - Lessons Learnt from Accidents Involving Dangerous Substances. EURCOURSE on "Loss Prevention and Risk Analysis in the Process Industry", CIEMAT, June 1991, Madrid, Spain - S.P./I.91.18

DROGARIS, G. - Review of Major Accidents - S.P./I.91.34

CONTINI, S. - 1. Review of Methods for Risk Analysis 2. Analisi dei Sistemi con la Metodologia dell'Albero dei Guasti - S.P./I.91.35

Preparatory Research

CONTRIBUTIONS TO PERIODICALS AND MONOGRAPHS

MILLAN-RUIZ, J., TORRAS, C. - Connectionist Approaches to Robot Path Finding. Progress in Neural Networks Series Ablex Publishing Corp., Norwood, NJ (USA) O.M. Omidvar (Ed.), Vol. 3 - ART 29946

MILLAN-RUIZ, J., TORRAS, C., BECQUET, M. - Autonomous Mobile Robots and Teleoperation. In: Teleoperation: Numerical Simulation and Experimental Validation. Kluwer Acad. Publ., M. Becquet (Ed.) - ART 40240

AVOURIS, N., HALL, L., OLIVEIRA, E., MUTA, F. - The Human Computer Interaction in ARCHON. In: An Architecture for Multi Agent Systems, Ellis Horwood, T. Wittigh (Ed.), Chapt. 5, pp. 77-91 - ART 40493

TECHNICAL EUR REPORTS

GROSSETIE, J., CHECCHI, E., STRAGAPEDE, C. - Diffusely Reflecting Radiosity Technique in Image Synthesis - EUR 13381/EN (1991)

HEIDRICH, D. - Implémentation des Langages C, Fortran et Pascal Parallèles 3L sur Machine MIMD à Réseau Reconfigurable: Supernode - EUR 13383/FR (1991)

GASSILLOUD, D., GROSSETIE, J.- Computing with Parallel Architectures: T.Node - EUR 13439/EN (1991)

GROSSETIE, J., HEIDRICH, D. - Architecture, Programming Environment and Application of the Supernode Network of Transputers (EUROCOURSE, 4-8 November 1991) - EUR 13975/EN (1991)

CONTRIBUTIONS TO CONFERENCES

NORDVIK, J., RENDERS, J. - Genetic Algorithms and Finite-State Automation Discovery: Potential Applications to Adaptive Process Control. In: Proceedings of the Intern. Symposium on Distributed Intelligence Systems, IFAC, 14-15 August 1991, Arlington, Va. (USA) 128-132 - ORA/PRO 35984

NORDVIK, J., RENDERS, J. - Genetic Algorithms and their Potential for Use in Process Control. A Case Study. In: Proceedings of the 4 th Intern. Conference on Genetic Algorithms, 13-16 July 1991, San Diego, Cal. (USA), Morgan Kaufmann Publs., R.K. Beleko and L.B. Booker (Eds.) - ORA/PRO 35985

CATENAZZI, N., ARGENTESI, F. - Super-Library, an Environment for the Conversion of Linear Texts into Supertexts. In: Proceedings of the Conference on Intelligent Texts and Image Handling (RIAO '91) CID 2 - 5 April 1991, Barcelona (E) - ORA/PRO 36092

MILLAN-RUIZ, J., TORRAS C. - Learning to Avoid Obstacles through Reinforcement. In: Proceedings of the 8th Intern. Workshop on Machine Learning, Northw. Univ. 27-29 June 1991, Evanstone III. (USA) - ORA/PRO 36198

AVOURIS, N., LEKKAS, G. - Cooperating Expert Systems: Experience and Perspectives. In: Proceedings of the 3rd Panhellenic Conference in Informatics, Greek Computer Soc., 28-31 May 1991, Athens (GR) 503-515 - ORA/PRO 36222

RENDERS, J., MILLAN-RUIZ, J., BECQUET, M. - Non-Geometrical Parameters Identification for Robots Kinematic Calibration by Use of Neural Network Techniques. In: Proceedings of the European Robotics and Intelligent Systems Conference (NTUA), 23-28 June 1991, Corfu (GR), Kluwer Acad. Publ. - ORA/PRO 36277

MILLAN-RUIZ, J., BECQUET, M. - A Reinforcement Connectionist Path-Finder. In: Proceedings of the 6th Intern. Conference on CAD/CAM, Robotics and Factories of the Future, South Bank Polytechnic, 19-22 August 1991, London (UK) - ORA/PRO 36334

RUIZ DE ANGULO, V., TORRAS, C. - Minimally Disturbing Learning. In: Proceedings of the Intern. Workshop on Artificial Neural Network s, IAEA, IEEE, 17-19 September 1991, Granada (E) - ORA/PRO 36425

TECHNICAL NOTES

VERSINO, C. - Studio per la Realizzazione di un Trigger di Puntamento Mediante Reti Neuronali - T.N./I.91.13

MASTRANGELO, V. - Modélisation Stochastique et Calcul Parallèle - T.N./I.91.58

VARFIS, A. - The FPE Criterion for MLP Models.;Derivations and Experimental Results - T.N./I.91.59

PANETSOS, F., ALONSO, J., BERJA, E., OLMEDO, V. - NS. a Language for Neural Network Specifications - T.N./I.91.63

MURCIANO, A. - Image Processing Using Neural Networks - T.N./I.91.92

PANETSOS, F., ALONSO. P.*, BARJA, E.*, OLMEDO, V.* - A Tool for Neural Network Applications Development - T.N./I.91.93

SOLA, A., SAVIO, M., MAFFEIS, G., HOHENADEL, M. - Industrial X-Ray Image Processing Using Parallel Supercomputer Models T-Node and C UBI 9000. First Interim Report - T.N./I.91.118

GLODEN, R. - Résolution Stochastique de Systèmes d'Equations aux Dérivées Partielles du Type Parabolique Affine. Cas de Domaines où les Coefficients Sont des Fonctions Continues par Morceaux - T.N./I.91.147

Work for Third Parties

TECHNICAL EUR REPORTS

CONTI, F., GREEN, C., SHARMA, V., MAZZARELLA, L. - SPIEL-CCR, Programma di Calcolo di Simulazione Dinamica per la Valutazione delle Misure di Risparmio di Energia nei Sistemi Edificio-Impianto - EUR 13475/IT (1991)

CONTI. F., ZABOT, S., MARCIANO, L. - BESIS (Building Energy Saving Information System), Sistema Informativo del Parco Edilizio della Regione Lombardia - EUR 13510/IT (1991)

SPECIAL PUBLICATIONS

CRUTZEN, Y., MARONI, M., MIGLIERINA, D. - STEERING, Spaziosystem TESLA Engineering - S.P./I.91.25

General Directorate, Administration Directorate

CONTRIBUTIONS TO CONFERENCES

GIACOMAZZI, G. - Sea Transport of Hydrogen. In: Proceedings of the Conference on Hydrogen: the Fuel Beyond the Fossil Fuels, CEC, IC I 17 April 1991, Bruxelles (B) - ORA/PRO 36161

GRETZ, J., ULLMANN, O. - Phase II of the Euro-Quebec Hydro-Hydrogen Pilot Project EQHHPP. Special Show Hydrogen Technology, ACHEMA, 9-15 June 1991, Frankfurt/M. (D) - ORA/PRO 36177

GIACOMAZZI, G. - Maritime Hydrogen Transportation. In: Proceedings of the Conference on Hydrogen within a Clean and Renewable Energy System, CEC, Ansaldo, Univ. Genova, 21-29 October 1991, Genova (I) - ORA/PRO 36488

GRETZ, J., GIACOMAZZI, G. - Phase II of the 100 MW Euro-Quebec Hydro-Hydrogen Pilot Project. A Hydrogen Based Clean, Renewable Energy System. In: Proceedings of the Intern. Conference on Technology Responses to Global Environmental Challenges, IEA, 5-8 November 1991, Kyoto (Japan) - ORA/PRO 36491

GIACOMAZZI, G. - The Euro-Quebec Hydro-Hydrogen Pilot Project (EQHHPP). Hydrogen, an Energy Vector within a Clean and Renewable Energy System. In: Proceedings of the 2nd Annual Meeting on Hydrogen Applications for Sustainable Future, USA Nat. Hydrogen Ass., 13-15 March 1991, Arlington, VA (USA) - ORA/PRO 36031

GIACOMAZZI, G. - L'Idrogeno come Vettore e Combustibile Energetico. In: Atti del Corso Perfezionamento in Energetica "G. Agnelli", 25 giugno 1991, Torino (I) - ORA/PRO 36278

TECHNICAL NOTES

BASTIN, F., VERAGTEN, E. - Visas par Lots - T.N./I.91.76

Informatics Centre

TECHNICAL NOTES

MOTA, S., PESTANA, S. - SYSCCR, Introduction au Système - T.N./I.91.41

POLLICINI, A. - A Discipline Use of Fortran 77 - T.N./I.91.79

BASTIN, F., CARLESSO, S., COLOMBO. A., DI MAGGIO, P., HOENIGSBERG, S.*, ZANOTTI, D. - SYSCCR - Procédures à Usage Général. Vol. 1 - T.N./I.91.110

BASTIN, F., BRITES, M., COLOMBO, A., DI MAGGIO, P., SOLER, P., VANSTEENKISTE, R. - SYSCCR - Comptabilité Générale. Vol. I et II - T.N./I.91.111

SPECIAL PUBLICATIONS

DOWELL, M., PIRELLI, G. (Eds.) - Informatics Services Newsletter No. 112, October - December 1990 - S.P./I.91.08

DOWELL, M., PIRELLI, G. (Eds.) - Informatics Services Newsletter No. 113, January - June 1991 - S.P./I.91.21

DOWELL, M., PIRELLI, G. (Eds.) - Informatics Services Newsletter No. 114, July - December - S.P./I.91.40

LIST OF FIGURES

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AAITCE	Advanced Computing, Knowledge Based Applications and Electronics
ABAQUS	Data Base Management System by Software AG.
ABB	Asea Brown Boveri
ADABAS	Computer language for database management
AEA	Atomic Energy Agency
AECB	Atomic Energy Control Board
AORS	Abnormal Occurrences Reporting System
ARCHON	Architecture for Cooperating Heterogeneous Online Systems
ASCOR	Automatic Systems and Components Organization
ASIC	Application Specific Integrated Circuit
ATM	Asynchronous Transfer Mode
BEAMES	Building Energy Auditing Management/ Expert System
BESIS	Building Energy Saving Information System
BHD	Blanket Handling Devic
BNFL	British Nuclear Fuels Ltd. BR Basic Research
BRITE	Basic Research in Industrial Technologies for Europe
CAA	Civil Aviation Authority
CAE	Computer Aided Engineering
CAHM	Computer Assisted Human Matching
CANDU	CANada Deuterium Uranium (reactor)
CARES	Computer Aided Review - Station
CASE	Computer Aided Software Engineering
CAVIS	Computer Aided Video Surveillance System
CBNM	Central Bureau for Nuclear Measurements
CDCIR	Community Documentation Centre on Industrial Risk
CEA	Commissariat à l'Energy Atomique
CEDB	Component Event Data Bank
CENELEC	Comité Europén de Normalisation Electrotechnique
CERN	Centre Européen de Recherche Nucléaire
CIR	Computerised Inspection Report
CISE	Centro Italiano Studi ed Esperienze
CNR	Centro Nazionale della Ricerca
CORDIS	Community Research and Development Information Service
COSIMO	Cognitive Simulation Model
COST	European Cooperation in Science and Technology

CRTN	Centro Ricerca Termica Nucleare
CSN	Consejo de Securitad Nuclear
DA	Developer Agent
DAI	Intelligent Developer Agent
DBMS	Database Management System
DCS	Direction Controle de Sécurité
DD	Degree Day
DG	Directorate General
DMA	Depth and Motion Analysis (Esprit)
DoF	Degrees of Freedom
DPS	Distributed Problem Solving
DSS	Decision Support Systems
DYLAM	Dynamic Logical Analytical Methodology
E-mail	Electronic Mail
EAC	European Accident Code
EAMA	Acoustic Emission on Aeronautic Materials
EC	European Communities
ECHO	European Commission Host Organization
ECO	Energy Conservation Opportunities
EDBMON	Experiment Data Base Monitor Program
EDBTOP	Experiment Data Base Desktop Program
EdF	Electricité de France
EDF	Experiment Data Files
EDSES	European Data System for Energy Saving
EIREDA	European Industry Reliability Data (Handbook)
ELCA	Electronique du Capitole (Toulouse)
ELECTRE	Programme package for decision making
ENEA	Comitato Nazionale per la Ricerca e per lo Sviluppo dell'Energia Nucleare e delle Energie Alternative (I)
ENEL	Ente Nazionale per l'Energia Elettrica (I)
EPR	Electric Power Research
EQHHPP	EURO-QUEBEC HYDRO-HYDROGEN PILOT PROJECT
EQUIS	Ercoftac European Research Community on Flow and Combustion
ERDS	European Reliability Data System
ESARDA	European Safeguards Research and Development Association
ESCAPE	Experts and Systems for Control of Air Pollution Episodes
ESPRIT	European Strategic Programme for Research and Development in Information Technology
ESTEC	European Space Technology Centre
ESTI	European Solar Test Installation
EuReDatA	European Reliability Data Association

EUROSTAT	European Statistical Office
FARO	Experimental Facility for Fuel Melting
FEA	Finite Element Analysis
FIRES	Facility for Investigating Runaway Events Safely
FISIM	Fires Simulator
FMECA	Failure Modes Effect and Criticality Analysis
FORMENTOR	Eureka project to develop expert systems for decision support in hazardous situations
FRG	Federal Republic of Germany
FSM	Finite State Machine
FWBS	First Wall/Blanket Segments
FWP	Framework Programme
GA	Genetic Algorithms
GEOSCOPE	Geographical information system
GILSP	Good Industrial Large Scale Practice
GIS	Geographical Information System
GMM	Genetically Modified Micro-organism
GMO	Genetically Modified Organism
GMP	Good Microbiological Practice
HARIS	Hazard and Reliability Information System
HCI	Human-Computer Interaction
HRA	Human Reliability Analysis
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEC	International Electronic Commission
IEEE	Institute of Electrical and Electronic Engineering
IMARED	Identifier for Magnox Reactor Deadweight
INEL	Idaho National Engineering Laboratories
INMM	Institute of Nuclear Materials Management
IRSA	Institute for Remote Sensing Applications
IRUSS	In-situ Readable Ultrasonic Seal System
ISEI	Institute for Systems Engineering and Informatics
ISO	International Standards Organisation
ITAPAC	Italian Packet Switched Network
ITER	International Thermonuclear Experimental Reactor
ITU	Institute for Transuranium Elements
IXI	International X25 Initiative
JRC	Joint Research Centre
KB	Knowledge Based
KBS	Knowledge Based System
KWICK	Knowledge Workers Intelligently Collecting/Coordinating/Consulting Knowledge
LAN	Local Area Network
LASCO	Laboratory for Surveillance and Containment
LASSY	Laser Surveillance System
LDTF	Large Dynamic Test Facility
LEU	Low Enriched Uranium
LOBI	LWR Off Normal Behaviour Investigation (Installation)
LOCA	Loss-of-Coolant Accidents
LOCAM	Lobi Control and Acquisition Monitor
LPG	Liquified petroleum gas
LWR	Light Water Reactor
MADES	Material Accounting Data Evaluation System
MAKEMAP	Programme package for map construction
MAPO	Management of the Po River Basin
MAPPAC	Management of Planning and Control
MAS	Multi-agent Systems Architecture
MCDA	Multi Criteria Decision Aid
MCH	Methylcyclohexane
MEB	Multi Element Bottles
MEDUSA	System for computer aided engineering
MEDVIS	Data Transfer from CAD to Visualization Software
MMI	Man Machine Interaction
MOLP	Multi Objectives Linear Programming
MOU	Memoranda of Understanding
MVS	Operating system on the main frame computer
NDE	Non Destructive Evaluation
NEA	Nuclear Energy Agency
NET	Next European Torus
NFS	Network File System
NNSA	National Nuclear Safety Administration
NPP	Nuclear Power Plant
NPT	Non Proliferation Treaty
NUCLAAR	Nuclear Computerised Library for Assessing Reactor Reliability
OECD	Organisation for Economic Cooperation and Development
ORACLE	Computer datavase system
OSI	Open Systems Interconnection
PASSYS	Passive Solar Energy System
PETRA	Facility for Treatment of Radioactive Waste
PIV	Physical Inventory Verification
PRAGMA	Computer program for decision support
PRIS	Power Reactor Information System
PSA	Probabilistic Safety Analysis
PSDN	Packet Switched Digital Network
PV	Photovoltaic
PWR	Pressurized Water Reactor
RAMINO	Reliability Assessment for Maintenance and Inspection Optimisation

RDD	Requirements Definition Document
RH	Remote Handling
RICETTA	Control Program of FIRES
RITO	Rifiuti Industriali Tossici
ROBERTINO	Facility for the Blanket Handling Device development in 1:3 scale
SCCS	Safety Critical Computer Systems
SER	Safety Engineering and Reliability
SERI	Solar Energy Research Institute
SGHWR	Steam Generating Heavy Water Reactor
SME	Small and Medium Enterprises
SMTP	Protocol for electronic mail handling
SNL	Sandia National Laboratory
SPLASH	2D Display Program
SRA	System Response Analyser
SRG	System Response Generator
SSA	Safeguards Systems Analyser
STARS	Software Tools for the Analysis of Reliability and Safety
STEP	Science and Technology for Environmental Protection
STI	Safety Technology Institute
SYSCCR	Integrated Information System of the JRC
TA	Technology Assessment
TAME	Tank Measurement

TB	Twin-Belt
TBR	Tritium Breeding Rate
TCP/IP	Communications protocol on the Local Area Network
TCT	Technical Committee for Telecommunications
TELEMAC	Teleoperation Laboratory
THERMIE	Technologies Européennes pour la Maîtrise de l'Energie
TN	Technical Note
TNO	Toegepast Natuurwetenschappelijk Onderzoek
TPW	Third Party Work
UIA	User Interface Agent
UTS	Operating system (Unix>) on the main frame computer
VALUE	Valorization and Utilization for Europe
VLSI	Very Large Scale Integrated Circuits
VME	Computer bus
VMS	Operating system of VAX Computer
VTT	Technical Research Centre of Finland
WTC	Winfrith Technology Centre
XFMS	X Windows Frame Management System
XFTCON	X Window Falt Tree Construction
XPLED	X Windows based Plant Editor
XQUAL	X Windows Qualitative Reasoning Tool

The report presents the achievements of the Institute for Systems Engineering and Informatics (ISEI) of the Joint Research Centre (JRC) of the Commission of the European Communities (CEC) for 1991. The JRC is a European scientific and technical research centre established by the member states of the CEC. Its four sites in Belgium (Geel), Germany (Karlsruhe), the Netherland (Petten) and Italy (Ispra) house 8 Institutes, each with its own focus of expertise.

ISEI, based at Ispra, was created in 1990 by the merger of the Institute for Systems Engineering (ISE) and the Centre for Information Technologies and Electronics (CITE).

The main areas of activity of the Institute are:

• Industrial and Environmental Risk
• Nuclear Safeguards
• Fusion Reactor Systems Integration and Safety
• Solar Energy Systems and Energy Management
• Advanced Computing
• Informatic Services