INSTITUTE ANNUAL REPORT 95

SYSTEMS ENGINEERING AND INFORMATICS
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JOINT
RESEARCH
CENTRE
EUROPEAN COMMISSION

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FOREWORD

1995 has been the first year of the JRC multiannual programme 1995-1998. Consequently the activities of ISEI have been oriented to implement the Council conclusions on the role of JRC as defined in April 1994.

In these conclusions the Council underlined "the need to add a new approach for the JRC whereby it would progressively enter the competitive arena, generally in networks with other laboratories, in specific programmes under the Framework Programmes to which it contributes, and for activities providing scientific and technical support for Community policies of a kind suitable for that competitive approach".

The Council recognised that "to achieve that objective and to allow flexible and dynamic operation of JRC, it was necessary to ensure a gradual transition and adapt existing rules and procedures" and decided that "for the period 1995 1998 the proportion of the JRC activities in the Framework Programme to be transferred should average 22% for the EC Framework Programme and 10% for the EAEC Framework Programme".

At the end of this first year of the JRC multiannual programme we note with satisfaction that the Institute has established a large number of networks with European organisations for submission of tenders on R&D projects (shared cost actions) and has submitted many offers to the Commission services for competitive scientific and technical support. At present more than fifteen ISEI project proposals have been accepted for funding and about thirty contracts have been signed with the various Directorates general for support to the Commission activities. In the mean time the Institute has pursued the work under contract with outside organisations.

During 1995, the permanent staff remained constant being about 200 people. The same applied to the non permanent staff including grantholders, visiting scientists and auxiliaries, about 40 people, to whom one has to add 45 visiting students. This is a demonstration of the interest of the Institute in hosting young scientists and in the mobility of researchers.

In September 1995 I joined the Institute as Director. Until that date the direction of ISEI was conducted by Dr. G. Volta, as acting Director. The successful achievements of the activities described in the report, particularly noting the new aspects of our work and the evolutionary character of our research programmes, are the testimony of the quality of his guiding and of the enthusiasm he has devoted in this task.

Towards the end of 1995 discussions started at JRC level for a re-organisation of the Institutes. This resulted in the decision of merging ISEI with the Institute for Safety Technology. The mission of the new Institute, named Institute for Systems, Informatics and Safety, is to be "the impartial centre of expertise of the European Union in the science and technology of safety management, the multidisciplinary analysis of industrial, socio-technical and environmental systems and the innovative applications of information technology". From the programmatic point of view the new Institute covers, among others, all the research activities previously covered by ISEI, apart from those related to non nuclear energy (photovoltaics and energy conservation) which have been transferred to the Institute for Advanced Materials. The informatics services have also been moved to the Administration and Infrastructure Directorate. I am confident that the new Institute will help to valorise the competence and the enthusiasm of the people and to favour the evolution of the JRC towards the new frontiers of the years 2000.

D. R. Wilkinson
Director of the Institute for Systems,
Informatics and Safety
Ispra, May 1996

1 INTRODUCTION TO THE INSTITUTE

1 INTRODUCTION TO THE INSTITUTE

The Institute for Systems Engineering and Informatics (ISEI) is one of the eight Institutes which constitute the Joint Research Centre (JRC) of the European Commission (see Fig. 1.1).
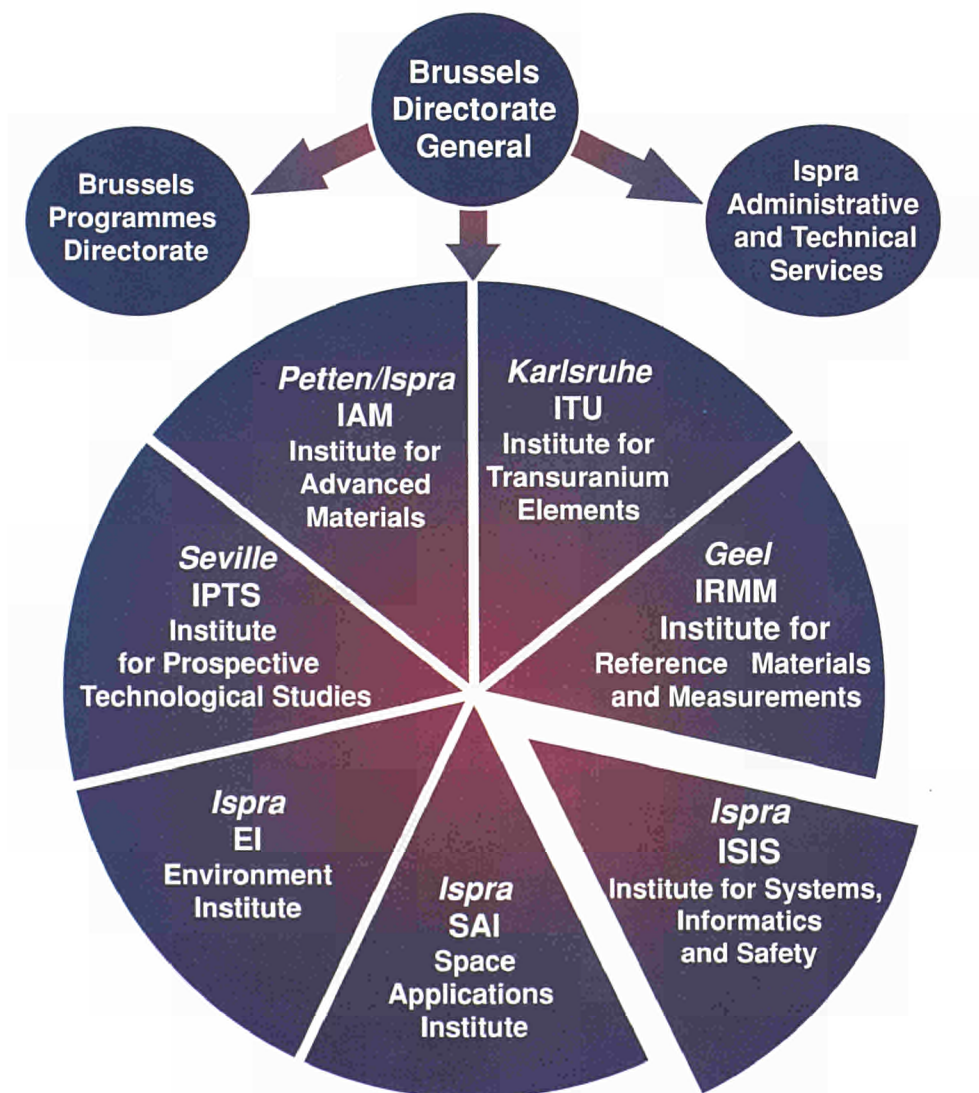
Fig. 1.1. The Joint Research Centre of the European Commission

For the execution of the programme activities, the Institute is organised into Units (Fig. 1.2.)

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                    Institute Director
                    David R. Wilkinson

                       Deputy Director
                          G. Volta

    Structural          Systems Modelling        Software
    Mechanics           and Assessment          Technologies
                           G. Volta            and Automation
                                                   F. Sorel

    Industrial             Advanced          Safeguards and
    Hazards             Techniques for          Verification
    A. Amendola f.f.  Information Analysis       Techniques
                          A. Lucia f.f.          M. Cuypers

              In-pile              Quality and
             Experiments          Management
           P. von der Hardt         Support
                                  K. Giegerich
```

Fig. 1.2 Organisation Chart of the Institute for Systems Engineering and Informatics

The Mission of ISEI is to be the European Union's impartial centre of expertise in the
- multi-disciplinary analysis of integrated systems which involve industrial, environmental, safety and human aspects;
- performance assessment of system components;
- innovative applications of information technology
- development of dedicated software and/or hardware for specialist applications.

ISEI develops and applies this expertise in many fields ranging from energy, transport and manufacturing, through information technology and telematics to natural resources and agriculture.

In common with the other JRC Institutes, ISEI exists to support the industrial base of the European Union and to improve the quality of life of its citizens. This end is achieved by making the first role of the Institute that of supporting the European Commission in all aspects of the implementation of Community policies where ISEI's expertise and independence, of both commercial and national interests, are relevant. ISEI's second role is to ensure that the Institute's expertise and technology are applied to the wider European economy and, when appropriate, transferred to industry. Finally, ISEI's third role is to co-operate with other JRC Institutes on research programmes where ISEI's specialist expertise is required and to support the JRC as a whole in the provision of informatics services.

ISEI is managed to provide a competitive and responsive service driven by customer requirements. The Institute, whose staff originate from across the diverse range of European cultures, maintains an

exemplary standard of scientific quality and acts as a unique focus for international collaboration involving industrial, university and government research laboratories throughout Europe.

Resources

The *human resources* available at the end of 1995 amounted to 289 people and included the following categories (see fig. 1.3.):
- authorised permanent staff, scientific-technical and administrative *(204)*.
- young visiting researchers (grantholders, mainly chosen and financed in the framework of the Human Capital and Mobility Programme *(37)*.
- senior visiting scientists and staff seconded from organisations (detached experts) in the Member States, mainly financed within the envelope of statutory staff credits *(3)*.
- visiting stagiaires, mainly students hosted in the laboratories for training and education *(45)*.
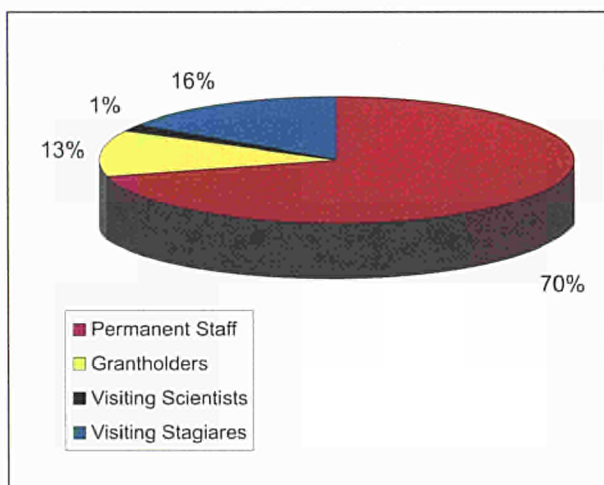
Fig. 1.3 ISEI Human Resources (31.12.1995)

Institutional activities

Institutional activities include both institutional research and institutional support to Commission services. The main areas of these activities are in the framework of the following specific programmes:

- Environment and Climate:
  - Proof-of-concept for the Centre for Earth Observation;
  - Integrated assessment of environmental quality;
  - Decision support systems for environmental management;
  - Reliability methods and human-machine interaction.
- Non Nuclear Energy:
  - Pre-normative research on photovoltaic energy.
- Nuclear Safety and Safeguards:
  - Probabilistic Safety Assessment;
  - Study of Safeguards technical requirements;
  - Development of new technologies for accountancy and verification purposes.
- Controlled Thermonuclear Fusion:
  - Operational safety and remote handling.

ISEI gives institutional support to various Directorates General of the European Commission in the framework of the following Community programmes:
- Information Technologies:
  - Safety critical computer systems (DG III).
- Environment and Climate:
  - Major accident hazard bureau (DG XI);
  - Biotechnology and environment (DG XI);
  - Support to the anti-fraude service (UCLAF).
- Agriculture and Fisheries:
  - Animal identification to prevent frauds (DG VI).
- Nuclear Safety and Safeguards:
  - Harmonisation of safety criteria DG XI);
  - Development of verification techniques (DG I and DG XVII).

Competitive activities

During 1995 ISEI has successfully established a firm base of work won in competition with other organisations. This includes:
- Participation in the shared-cost-actions of the Framework programme.
- Participation in other EC calls for tender
- Work in response to requests from the Commission Services for activities in support to Community policies which are suited to a competitive approach.
- Work for third parties.

ISEI has been selected to participate in 17 *shared-cost action* research and development projects in the following lines of the Framework Programme:

— Advanced Communication Technologies & Services (ACTS)
— Environment & Climate
— Industrial & Materials Technologies (BRITE-EURAM III)
— Non Nuclear Energy (JOULE R&D)
— Nuclear Fission Safety
— Technology Validation & Technology Transfer Projects
— Telematics Applications
— Training and Mobility Research (TMR)

ISEI has won competitive support to the Commission Services in the following areas:
— Antifraud Data Analysis;
— High Power Computing Networks;
— Waste Treatment;
— Technology Transfer, Exploitation Projects;
— THERMIE, SAVE and ALTENER Projects;
— Analysis of Statistical Data

Work for third parties has been performed in the areas of:
— Mechanical Performances of Transmission Components;
— Photovoltaic Component Testing;
— Software for Industrial Plant Supervision;
— Route Cause Analysis of Human Errors;
— Software for Safety Reliability Assessment;
— Ultrasonic Sealing Systems for Safeguards
— Regional Projects in Sicily (Italy (Water Management, Air Pollution, Erosion of Soil, Safety of Chemical Plants, Protection of Cultural Heritage)

2 INSTITUTIONAL ACTIVITIES

ENVIRONMENT AND CLIMATE

European Wide Service Exchange (EWSE)

A network information exchange has been developed for the Centre for Earth Observation by ISEI. Its objective is to help customers and providers of EO data and services find each other, and to attract new users and applications of EO derived data. The EWSE is interfaced to the World Wide Web (WWW), and is therefore accessible by a very large user community. It has some unique features, which overcomes previous limitations of WWW interfaces to on-line databases. Firstly the system handles user logons and profiles, which allows the user interface to be customised. Secondly, the information contained in the EWSE databases is entered, updated and customised by the EWSE users themselves. Unlike other Web servers which are maintained by a single source, EWSE is a dynamic system which belongs to all its users.

Service providers, universities and organisations advertise data and products via a virtual "Tradeshow". The tradeshow is organised according to thematic "pavilions". Each shop page and its associated products can be edited and updated remotely by the shop owner. Similarly, individual users can describe their research interests via their own "home page" (Figure 2.1.). They can then contact other users and the data suppliers directly within the EWSE interface.

To guide users through the database, there are several search tools. Companies and suppliers are found in the "Yellow Pages" guide (Figure 2.2.), while users are found in the "White pages" guide. Applications and products can be found in the "Product Guide" which includes a free text inquiry. Information can also be located geographically via "navigators". These allow users to specify a country
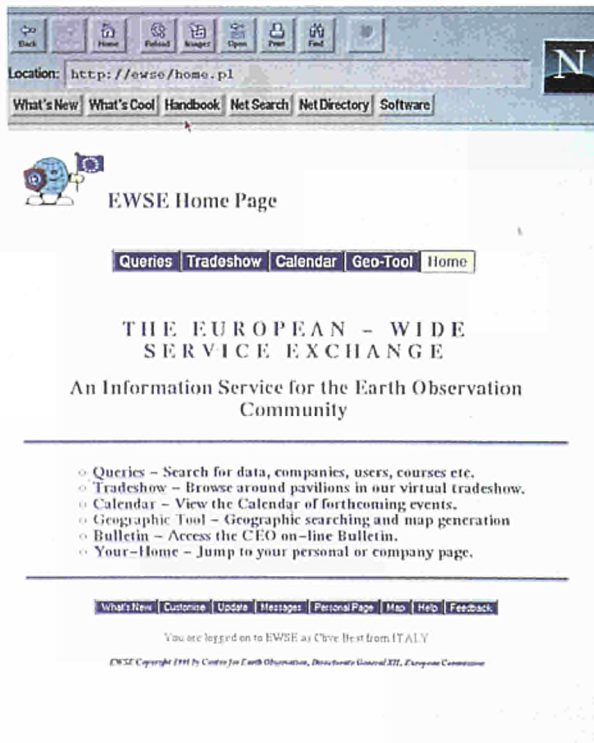

Fig. 2.1 The EWSE home page as seen by Netscape. The various services can be accessed via the displayed icons e.g. the Tradeshow.
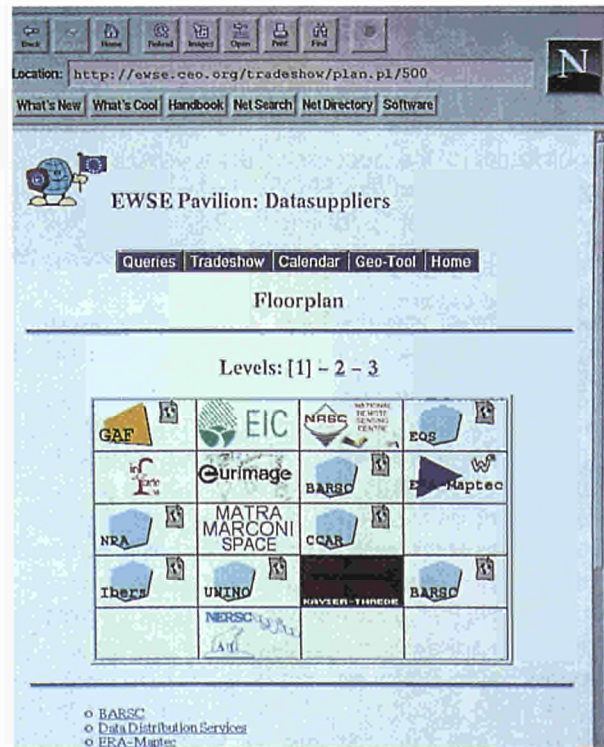

Fig. 2.2 The Tradeshow interface of the EWSE. Shown here are the companies and service providers from the Value Added Industry. Each company has installed and customised the presentation accessible via the various icons.

name or click on a world map overview. A 3-d navigator displays the Earth's terrain from different heights.

EWSE began operations in October 1995. Already over 700 users and 100 organisations have registered. The usage of the server is growing daily, and as a result an upgrade in the server power is planned.

References:

/1/ The European Wide Service Exchange, EWSE development team, EEOS workshop for Catalogue developers and operators, Presented C.Best, DLR-DFD, Oberpfaffenhofen, Germany, December 1995.

User Interface for CEO (Centre for Earth Observation)

The Institute for Remote Sensing Applications (IRSA), which is responsible for the Centre of Earth Observation (CEO) project, involved ISEI in the project with an agreement for a research project on a "User Interface to the European Wide Service Exchange". This research is related to the definition of two of the main targets of the CEO project: to "contribute to the successful establishment of an operational system (the EEOS)" for European Wide Service Exchange, "adapting flexibly to future needs of the users and to changes in data sources"/1/.

The agreement specified the "end user as decision maker in the context of a test study (in the field of Urban Planning)" /2/.

Data used for townplanning are usually derived from human interpretation of airborne images or direct observations on the site. To avoid these cost- and time-intense types of research, a data source has to be found that is updated regularly and interpreted automatically. An instrument that observes every site regularly already exists: the satellite. Is it possible to derive useful information on the townscape from the actual satellite imagery? To check this satellite images have to be integrated into the database for townplanning and examined with reference to a specific task.

The current project has enabled the detailed study of a case of considerable interest; the case of the

City of Florence. The end-user has been identified as the "Public Department for Green Issues" (Settore Verde Pubblico) of Florence's Municipality, since the project treats data relatively easily detectable on the municipally owned database.

The characteristics of this end-user in terms of (a) his requirements (for geographical data), (b) his access to existing data, (c) his existing systems for handling and analysing georeferenced data and (d) his capabilities have been identified and specified. This user is considered to be a representative prototype end user of data accessible through the CEO Europe Wide Service Exchange (EWSE) because he is typical of the type of user to be found in many local authorities throughout Europe. The required data and functionalities have been outlined.

To evaluate the different data sources to be integrated to create the database corresponding most closely to user requirements, the whole panorama of digital data available on the territory of Florence Municipality has been elicited by interviews with representatives of the different companies and institutions which are data owners.

The result is a jungle of different technical, administrative and logical problems in terms of multiple hardware/software systems, data formats, geographical extensions, geographical detail and thematical definitions, copyright and other legal restrictions. (Discussions with other GIS developers engaged in urban-related tasks confirm that this lack of homogeneity in terms of data formats and storage is characteristic for European cities).

The work environment had to be chosen following the main goals of the end-user:
– compatibility with as many systems as possible in the Florentine environment-update possibilities (integration of satellite images)
– flexible user interface (specific facilities for application design)

ARC/INFO corresponds to these requirements and has been declared by the Commission of European Communities (CEC) as the new European standard GIS. It was one of the first GIS on the market and has been confirmed during a long period.

Various data had to be integrated: the geographic data from Florence Municipality and from the "Set-

tore Verde Pubblico" in GEOSYS format (non standard presently used by the prototype end-user - the numerical ORACLE forms of GEOSYS are directly readable from inside ARC/INFO without transformation) satellite images, manual numerical insert (required data not yet existing or assessable in digital format). Future developments had to be foreseen in terms of possible data transformation and import (ENEL: ARC/INFO, FIORENTINAGAS: GEOSYS, ...) in advance of agreement between the institutions.

The database conserves the division of thematical layers of Florence Municipality. The geographical data of the "Settore Verde Pubblico" added two thematical layers ("single trees", "public green areas") and a completely different structure in

Fig. 2.3 Map-composition on different geographical data

geographical extension. The different modules of the application allow visualisation, query, insertion and hardcopy output either on single units or on the complete data set of the municipality, with possibilities of individual zooming.

The user interface has been set up to take special account of the professional skill of the end users and the specific use of the application.. The needs of the end user have been clearly defined in terms of data transformation, input, display, layout and print options needed for the work at the "Settore Verde Pubblico". Then the requirements have been transformed to sub-menus in ARC/INFO. A menu element corresponds to every logical interaction

foreseen between end user and database. This kind of user-interface-design helps to save time in education for the hand-on user at the public administration and transforms the GIS from an expert software to a useful every-day tool for decision support in town planning and management.

Although none of the existing data are yet available across any network it seems to be only a matter of time until this situation will change, thanks to the latest agreements with other institutions and networks. Because of this, the research of relevant data across the EWSE has been focused on relevant remotely sensed data.

To evaluate the currently available remotely sensed data on the network, other search engines have also been used to compare the results with the hits for the EWSE (CEO) search engines. For the comparison different search engines of general use and some relevant search keywords have been chosen. Since the application should be a test case for an urban application in Europe, the research concentrated on European high resolution ground data in general.

The query on all of the search engines retrieved mainly raw satellite data and some (very few) tandem images and treated data (U.S., Global change data, catastrophes). The main applications mentioned in the different documents were: Global change/Climate applications, Forestry applications, Land use (mainly U.S.). No urban application has been identified, just raw data and geometrically corrected images.

A very good result has been obtained for the CEO search engines: The CEO Expert Search reached all the images on Florence that have been retrieved by all the other search engines together. This means, that this specific search engine is a very helpful tool in Remote Sensing research.

This research queried also the list of satellite imagery used for the MARS project of IRSA, which used
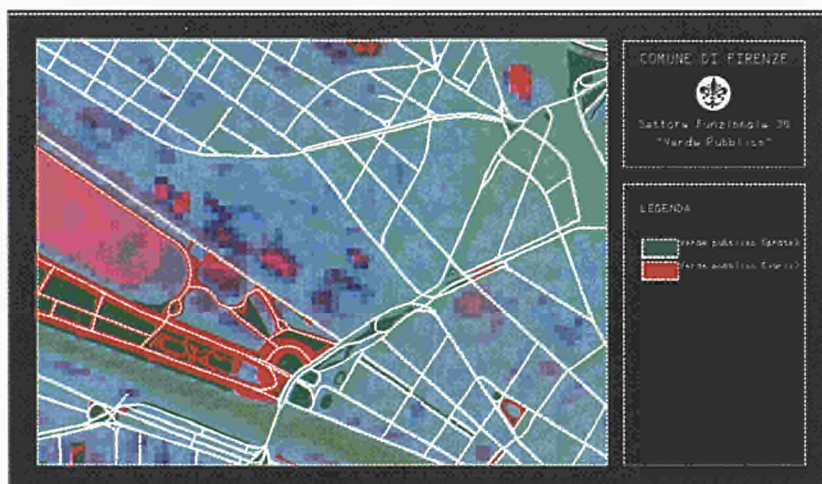
Florence as one of its test sites. One of these images (SPOT 20-March-1992) was chosen, geometrically corrected and contrast enhanced and introduced to the case study application, as background image. This image has been classified on use of soil using the EUROSTAT standards for urban and suburban classes.

The compatibility with the WWW has been assured for the sources actually available across the network and future possibilities of direct connections to the rest of the sources have been outlined. For the inter-collaboration between different end-users on different systems a gateway between WWW and GIS application has been indicated as one main request for the future; a prototype is currently under construction at ISEI. The application has been presented to and discussed with representatives of the end user institution and proposals for improvements have been made.

The research showed, that:
— the EWSE offers a new fast way to reach European urban data;
— the case study application opened new ways for data flow optimisation;
— the representatives of the municipality organisations showed wide interest in the use of remotely sensed data on urban environment and outlined some specific user-requirements for future research.

Reference:

/1/ Doc. CEO/115/1994, Version 1.0.06.10.1994

On Line Satellite Data Archiving and Distribution Techniques

The exchange of information and data between organisations within the CEO project requires that exchange mechanism at various levels be evaluated and benchmarked. As a consequence and in order to promote and establish an advanced common standard for satellite image data archiving and distribution techniques, a prototype informatic system has been implemented and tested on existing European computer systems.

Signal compression techniques, based on wavelet fast transforms have been improved and implemented at the ISEI-3D Image Laboratory, using satellite images distributed by NOAA, SPOT /1/.

The improved version of the computer software ONDATRA (release 2.0.0) has been implemented under VINCI workbench on European SPIRIT working stations running UNIX operating systems but in conformity with the European norms POSIX /2/.

New image and holographic compression techniques have been adapted to be used for transmissions through networks and for archiving data of satellite images. Original signal compression techniques, based on fast transforms and holographic compression developments have been realised, implemented, demonstrated and tested on special images. The applicability of these techniques to satellite images (SPOT, NOAA) has been evaluated in view of obtaining fundamental improvements with respect to the present state of art and developments performed at ISEI /3/.

After having tested the software on "the JRC satellite images" which are available, it would be necessary to demonstrate the validity of the concept using other satellite images directly given by satellite owners without any modification with respect to the original satellite image data.

Subject to the agreement of the CEO team, it has been decided to create a European scientific network gathering the main European satellite owners. The title of this scientific network would be "On-line satellite data archiving and distribution techniques".

The activities within this network are foreseen to be the following:
— Build up a team of satellite owners
— Implement a common strategy for archiving data
— Implement a common strategy for accessing data in real-time
— Implement a common strategy for data distribution
— Build up a common library of existing interpretation programs
— Build up a show case for a high speed on-line system

In such a way, each network partner and each CEO end-user will have the possibility to compress and

decompress by themselves the satellite images in real-time, using the international telecommunication networking.

References:

/1/ Description et Documentation du Logiciel AM-NET du CCR, Rapport Final, Juillet 1995, M. Amsellem
/2/ Mise en oeuvre et Source du Logiciel AM-NET du CCR, Rapport Final, Juillet 1995, M. Amsellem
/3/ Progress Report for the CEO - Doc. ISEI/T0180/002/95, On Line Satellite Data Archiving & Distribution Techniques, J.C. Grossetie, M. Amsellem, J.C. Francescatti

Integrated Environmental Assessment

The management of environmental issues increasingly demands co-ordinated inputs of a great variety of research disciplines belonging to the natural and social sciences. To accomplish this requires "integration" in several senses: over the various disciplines, across communities of providers (research) and users (managers, advisors, decision-makers), and finally over the different scales of problems (local, regional, continental and global) /1/. This effort is still embryonic, and in the process of forming its own identity. At the core of "environmental assessment" are mathematical techniques, including information systems, statistical programmes, or computer models. These are developing rapidly, and the establishment of common methods and of quality criteria is becoming urgent /2/.

The work undertaken includes the examination of existing approaches, relating them to the European reality and needs, and their possible application to specific regional or sectorial environmental quality issues /3/. Periodic "benchmark" exercises are envisaged, in which criteria of "good practice" will be formulated, applied, tested and enhanced.

To foster this development, a Workshop on Integrated Environmental Assessment was held in May 1995, organised jointly by DG XII/D-5 and JRC/ISEI /4/. The research and the policy communities from Europe were both represented, and in addition some invited experts from North America made a valuable contribution. After a detailed review of the state of the art, the Workshop adopted a set of recommendations, centring on the establishment of a Research Forum for Integrated Environmental Assessment. It was recommended that the terms of

reference of such a Research Forum could be along the following lines:
— it would establish collaboration and exchanges between providers and users; between different types of knowledge and skills, and between existing and new approaches;
— it would enhance the strength of national initiatives;
— it would provide foci for mutual learning on key problems and processes.

Its activity would be based on the experience that separate researchers do not always resolve the issues of methodology and quality; but rather that this communal "value-added" activity needs to be fostered by special arrangements. The key to the integrating functions of the Research Forum would be the active involvement of both researchers and users.

Its principal tasks would be to improve the management of quality of the information used in environmental assessments, to strengthen the links between analysis and policy, and to encourage research to be genuinely oriented around applications /5/.

The Research Forum would have a foundation in ongoing activities, both the projects supported in the research programme of Environment and Climate (Human Dimensions of Environmental Change, and in the research work at the JRC/ISEI. The European Environmental Agency would be a natural participant, and has already expressed interest. The Research Forum could provide a conduit of information and advice between those centres and other DG's that are involved in environmentally relevant fields.

References:

/1/ Munda, G. (1995). Cost-Benefit Analysis in Environmental Integrated Assessment: Some Methodological Issues. JRC, EN N. 9500643
/2/ Castells, N. & Munda, G. (1996) International Environmental Issues: Towards a New Integrated Assessment Approach. Presented at the Inaugural Conference of the European branch of the International Society for Ecological Economics_, Paris, May 23-25 1995.
/3/ Castells, N. & Ravetz, J. (1995). Uncertainty and Post-Normal Science in the Area of Transboundary Risk. Transboundary Environmental Risk Management in an East-West context. Stockholm, 20-22 August 1995, IIASA.
/4/ Bailey, P.D., Gough, C., Chadwick, M.J., & McGranahan, G. (1995). Methods for Integrated Environmental Assessment: Research Directions for the European Union. Stockholm Environment Institute. Bruxelles, May 1995.
/5/ Castells, N. & Funtowicz, S. (forthcoming). Integrated Assessment and Environmental Policy: First-Comers and Late-Comers. In S. Tognetti (ed.) SCOPE.

Decision Support Systems for Environmental Management

Given the high complexity of environmental management problems, the variety of stakeholders involved, the substantial areas of uncertainty and the sub-optimal specificity of expert advice, the approach chosen for development of DSS (Decision Support Systems) is based on Multiple Criteria Decision Aids (MCDAs). Since the focus is on specific and real-life environmental management problems, particular attention is given to uncertainty, divergence in stakeholders' value perceptions, the problem of "emergent complexity" and the issue of information quality. As a consequence of the substantial experience gained in this area, the group has now developed DSS sufficiently powerful and robust to incorporate concepts and techniques such as expert systems, fuzzy logic, GIS (Geographical Information Systems) and genetic algorithms.

A number of such DSS have been conceived, designed and applied to problems ranging from overseeing the clean-up of polluted river basins, through management of hazardous industrial wastes to evaluating alternative scenarios for disposal of solid urban waste. Implementation ranges from standard PCs to sophisticated UNIX work-stations on the hardware side, from Windows to Xwindows as Graphical User Environment and with mainly the C family of programming languages as development environments.

As a natural outcome of the activity on environmental problems ISEI has a developing interest, aided by recent recruitment of social scientists, in more general socio-economic topics, particularly at regional level. Growing appreciation of the need to accommodate technological development within the context of sustainable development adds a new dimension to both innovation and environmental studies. The emergence of new complementarities and feedbacks adds substantial complexity but this is a price worth paying for a more comprehensive understanding of the dynamics of modern innovation systems. The advent of powerful new decision aids, partly as a result of the dramatic advance of low-cost information technology tools, means that policy-makers at all levels (including the general public) will have a capacity to comprehend and manage complex systems to a degree that would have been unimaginable only a few years ago.

Decision Support Systems for the Management of Water Resources

The problems of water management require an integrated approach which transcends the boundaries between water, land and environment, and interrelates water with broader policy questions associated with social and economic development. It is also necessary to ensure that water is managed and used so that development may be sustained over the long term. At this level we must also consider the role of water in producing hydroelectricity, in facilitating transportation of goods and in serving as an input to manufacturing or industrial production.

If co-ordinated management of water resources is to be achieved, the scope of a holistic approach must be carefully thought through. .At a strategic level, a comprehensive viewpoint is desirable. This involves scanning the widest possible range of information. At the scientific level this implies access to all possible theories, data and knowledge bases and scientific results.

At the operational level, however, a more focused approach is needed.. Thus a bounded holistic perspective can be achieved which leads to common findings and objectives. At the operational level (with a more appropriate scale and time frame) the attention is concentrated upon those issues and variables judged significant.

To this end a dual strategy has been adopted, combining the more traditional "engineering model", incorporated in a standard DSS, with an "enlightenment model" as represented by the "garbage can" approach. This takes its name from the absence of a tightly organised information structure: everything is put together and it is up to the user to find relevant information. This kind of information structure can be quickly built via a communication network, and does not require a sophisticated user interface. It requires only that the information 'on the market' is identified and connected to the network. The eventual aim is to link this to the World Wide Web.

The capabilities of the "garbage can" system include access to data in the form of catalogues, reports, relational data-bases, geographic information systems (GIS) and tools for modelling and analysis of data. It is then linked with a decision support

system, which can be seen as a post-processor applied to a selected and well structured sub-set of information for a more normative approach. It runs for any suitable case, supporting an integrated water resources management problem.

Risk and Environmental Management of Marine Transport

A comprehensive risk assessment model for marine transport of dangerous goods has been developed by use of empirical analysis of a large accident database, combined with thorough literature study. The accident analysis and model development was performed in three steps:
- analysis of accident frequencies;
- analysis of accidental releases (probability and size distribution);
- analysis of consequences (human and environmental).

As a basis for this work a large data base of descriptions of accidents involving hazardous chemicals from all over the world has been developed. This data base, CHEMAX, includes a total of approximately 5000 accidents, of which some 1700 are related to marine transport. Further, as a background to the study, the quantities of dangerous goods were established at a detailed level for Danish waters and, at a less detailed level, for world base and European estimates. It was found that approx. 45 million tonnes of dangerous goods are transported per year in tankers in Danish waters.

The overall accident frequency for all tankers was estimated to be 3 per 10^6 ship-miles. The casualty rate was found to be approximately an order of magnitude lower than the accident rate, and the total loss rate was found to be approximately two orders of magnitude lower than the accident rate. Clear influence on accident frequencies has been established, through literature study and recent empirical analyses, for the following factors: geographical environment, cargo type, visibility and brightness, and the age of the vessel.

The probabilities of having a release, given that an accident has happened, were modelled on the basis of results in the literature as a function of the vessel type and accident type. Values between 0.05 and 0.25 were found for single hull vessels for different accident types. For double hull vessels the values for groundings and collisions were found to be approximately a factor 10 lower, whereas the values for structural damage and fire/explosion where assumed to be similar to those for single hull tankers. Based on accident data in CHEMAX the probabilities of a release of more than 100 t were estimated to between 0.014 and 0.058 for single hull tankers and 0.02 for double hull tankers/liquid gas carriers.

Models for release sizes were created based on data from CHEMAX. The release size was found to be a function of accident type and vessel size. It was shown that the presence of a fire and/or explosion subsequent to the initiating event is an important factor, and that release sizes are much higher in these cases. It was found that the distribution of numbers of fatalities from accidents which have happened during marine transport of dangerous goods is correlated to whether the cargo had an influence on the number of fatalities, the transportation phase, and the accident type. In almost all accidents resulting in fatalities there was a fire/explosion either as primary accident type, or subsequently.

Estimation of the probabilities of fatalities given an accident was done for the four primary accident types. It was found that fire/explosions have the highest probability of resulting in fatalities, followed by collisions, and with groundings/structural damages having the lowest probability of the four types.

As regards environmental consequences, it was found that crude oil and oil products when released in the environment generally have a higher potential for creating environmental consequences worth describing in accident reports.
The type of environmental consequence most often reported is shore pollution. It was found that there is a correlation for oil releases between a lower limit of the reported number of kilometres of shore polluted and the quantity of oil released.

New version of the XTRIM computer program
Based on the above, a new version of the computer program XTRIM was created. The latest version of the program (XTRIM 2.5) can be used for estimating the risks from road, rail, and marine transport of dangerous goods within the main transportation networks of Europe.

Using XTRIM 2.5 risk estimates were made for marine transport of dangerous goods in Danish waters and for oil transport in European waters. The results were then validated. For Danish waters it was estimated that vessels carrying UN Class 2, 3 or 8 goods will be involved in 6 accidents per year. The number of releases per year was estimated at 0.8 and the expected number of fatalities from accidents where the cargo had an influence on the number of fatalities was estimated at 0.5.

STARS v.2 - Knowledge Based Systems for Safety and Reliability Assessment

The STARS methodology and related software tools designed in the previous years for safety analyses and risk assessment were further developed. Additional features include the effective modelling of a complex industrial system, the management of these modes over the life-cycle of the system, the exploitation of corporate data available in CAD and data-bases, and access to all the information through the network.

The STARS methodology and tools offer:
— a structured approach for system representation, improving consistency and traceability;
— a full integration with knowledge and data bases that can be used for capturing the general domain expertise of safety and reliability analysts;
— the possibility of incorporating system experience as well as knowledge and experience deriving from analyses of other systems;
— a computer-based explicit documentation of the analysis, its underlying models and assumptions;
— a highly interactive and flexible environment for rapid creation and modification of the representations.

The STARS v.2 toolkit consists of the following tools.

— **STAXED**, Stars TAXonomy EDitor, is a general purpose graphical editor for hierarchically-structured knowledge bases (see fig. 2.4). The user has access to a taxonomy browser for editing the structure of the knowledge base, to a taxonomy item editor for the definition of the components of the knowledge base, and to dedicated editors for editing individual attributes. Full inheritance of the attributes of the taxonomy

Fig. 2.4 STARS v.2. Knowledge Base and Plant Editing Tool

items and mechanisms to override their values are provided. These attributes are classified into a number of pre-defined types, including complex types such as graphical icon, production rule and spreadsheet.

— **XPLED**, X Windows Plant Editor, is a computer-aided design editor for modelling complex plant for the purposes of risk assessment (see fig. 2.4). This includes, for a given system, the construction of its structural and functional models, the management of these models, and their evaluation in terms of user-defined risk assessment criteria. The components of a model are instances of objects created and maintained by the **STAXED** package. Attributes can be inspected and modified by the user for further customisation in an individual model.

- **XFTCON**, X Fault Tree Constructor, is a software package for the semi-automatic construction of fault trees. The construction is based on the information available in the **XPLED** models. The construction is initiated by a top event expressed as an abnormal value of a physical variable at a specific location in a plant layout. The fault tree is constructed incrementally and displayed directly to the user who may interactively modify it.

- **XFTED**, X Fault Tree Editor, is a graphical editor for the creation and modification of fault trees (see fig. 2.5), such as the fault trees generated by **XFTCON**. Typical editing functions are available, such as modification of the structure and of the logic of the fault tree as well as of the reliability characteristics of the basic events. A powerful compress and transfer facility as well as zoom options enable the manipulation of large fault trees.

- **XFTAN**, X Fault Tree ANalyser, is a software package for the qualitative and quantitative analysis of fault trees generated by **XFTED**. The package covers minimal cut set determination, probabilistic analysis and boundary condition handling. Text file reporting and histogram representation are available. Temporal analysis of unavailability and the expected number of failures and their corresponding graphical representations are provided.

All these tools have been validated on case studies or intensive test procedures. They are available on SUN OS 4.1.x and Solaris 2.5, Power PC and RS-6000 AIX 3.2, Dec workstations as well as and under Windows NT and Windows 95. It is to be noted that all the software packages have been developed according to professional software engineering practices, in C++ with the use of dedicated libraries for cross-platform interface development.

STARS v.2 and subsequent services based upon the system, have been the subject of a number of successful commercial activities in which the tools were tailored to specific user's needs for installation on site. In particular the development of a "Consequence Assessment Tool" to model and analyse courses of undesired events has been started (see fig. 2.5). A number of consequence models have been developed, as well as of a graphical interface to indicate on the plant layout the results of these models. A "phenomenological event-tree" editor is also under development to describe possible event scenarios, with particular attention paid to "domino effects".

References:

/1/ J.P. Nordvik, A. Carpignano and A. Poucet, "Computer-Based System Modelling for Reliability and Safety Analysis and Management", in Proc. Topical Meeting on Computer-Based Human Support Systems: Technology, Methods and Future, Philadelphia, Pensylvania, June 25-29, 1995, Published by American Nuclear Society, p 211-217.

/2/ J.P. Nordvik, A. Carpignano and A. Poucet, "The Benefits of · Using Safety Mangement Information Systems", to be presented at PSAM, June 24-28, 1996, Crete, Greece.
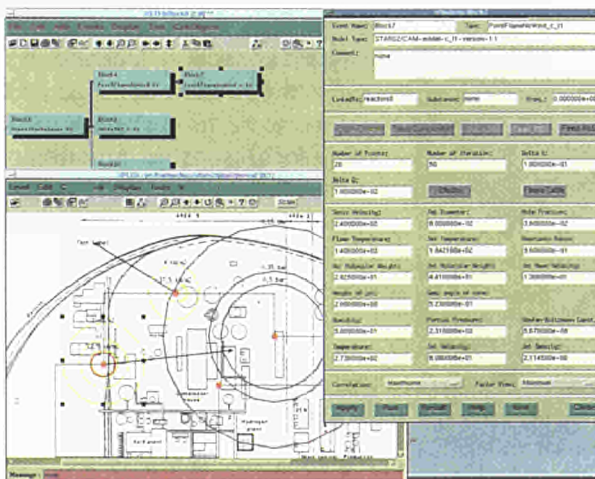
Fig. 2.5 STARS v.2. Consequence Assessment Tool

NON NUCLEAR ENERGY

Photovoltaic Systems

ESTI helped organise and technically chaired the highly successful 13th European Photovoltaic Solar Energy Conference and Exhibition, held in Nice in October 1995. The Conference attracted over 1200 experts from 55 countries and the exhibition over 100 exhibitors /1/.

ESTI participated in two international intercomparisons (round robin) of modules and cells. The samples were part of a third intercomparison (PEP'93 Round Robin Calibration) and was an initiative of the Solar Energy Project of the Technology, Growth and Employment Working Group of the G7 Summit.

Basic research was performed on the capacitant effect on silicon solar cells on their transient light conditions. These capacitants could be used in new applications as electronic light-dependent elements.

EN4500 Laboratory Accreditation

During 1995 the ESTI Laboratory started to prepare the work necessary for laboratory accreditation for third party work (module qualification and solar irradiance device calibration) according to EN4500.

To avoid regular shipment of laboratory equipment to national/international calibration bodies ESTI implemented a new laboratory in order to provide calibration services for the instruments used during these tests. Among the many standards the calibration laboratory holds are primary ones for solar irradiance and secondary ones for voltage and resistance and temperature.

Accreditation of the tests performed for third parties at ESTI is foreseen for mid 1996. Future possibilities would be the accreditation of the calibration laboratory in order to calibrate.

The ESTI-Sensor

The ESTI-Sensor is based on a monocrystalline silicon solar cell cut in two, packed in a glass/EVA/polyester-aluminium-tedlar laminate. It was developed and presented by ESTI in 1992 and has been chosen for the market as a reference device for the monitoring and evaluation of photovoltaic (PV) installations because it measures both the irradiance the plant is exposed to, as well as the operating cell temperature of the photovoltaic modules installed. It has a lifetime of 20 years and meets with IEC 1215 requirements for PV modules. It is also suitable for use with low-cost measurement electronics and offers good spectral and optical match with PV modules. It is already in use at 400 monitoring sites. During 1995 the market continued to grow and by the end of the year some 600 sensors had been sold. Work started on the implementation of a micro-controller unit for the next generation of ESTI-sensors.

A paper was prepared and presented at the 13th Photovoltaic Solar Energy Conference, evaluating the calibration results for 600 of these solar irradiance sensors.

Fig. 2.6 The European Solar Test Installation Stand at the 13th European Photovoltaic Solar Energy Conference and Exhibition, Nice, 23-27 October 1995.

They were built in three different designs and by two different suppliers and within the second and third batch sensors with black or white front sheets were produced. The quality of the product and of the calibration method itself were evaluated and discussed. The spread of calibration values was evaluated for each of the three designs separately. The calculated statistical distributions of values were normalised for better comparison. The results may improve the quality on both production and calibration and lower the cost of the product.

PV Laser Scan Facility

Laser scanning is a well known non-destructive analytical technique with high spatial resolution for the electrical characterisation of PV-device performances. At ESTI's laboratories a multi-laser scan facility has been set up. A fast data acquisition system has been implemented in order to allow an on-line visualisation of the recorded Light Beam Induced Current (LBIC) and/or Light Beam Induced Voltage (LBIV) mapping. High resolution pseudo colour images were obtained and displayed by accurately filtering the measured signal with the home developed software ESTISCAN, which also controls the entire scanning system. The different lasers gave information on the uniformity of the current generation and on the cell manufacturing defects at different penetration depths.

Façade

Following the installation of one of the biggest amorphous silicon photovoltaic facades in the world, ESTI monitors data of interest every five minutes. This data is stored and evaluated to demonstrate the functioning of the whole installation, as well as the performance of its components. As a result of the evaluation, one can say that the set-up of the system is extremely reliable compared with previously monitored PV plants within European demonstration programmes.

Reference:

/1/ Special Publication N° I.95.55, Unit Energy Environment Interaction, Pre-print of Papers, 13th European Photovoltaic Solar Energy Conference

Further Development of Energy Auditing Techniques

During 1995 the activity aimed at setting up advanced methodologies in the field of building energy auditing has continued, with more focus on the application aspects.

The software package BEAMES (Building Energy Auditing Management Expert System), developed in previous years, has been presented on various occasions in many countries. The BEAMES method employs a Neural Network pattern associator which makes it possible to identify, with a very simple and reduced amount of building data, the likely Energy Conservation Opportunities applicable for the building energy retrofit.

Its advanced features (ease of operation, simple input data, high speed of production of output results, automatic reporting, etc.) make this tool very attractive for extensive retrofit actions in regional and urban areas.

At the moment, BEAMES is a prototype for demonstrating the basic methodology based on an Artificial Neural Network. From this methodology various detailed application objects can be produced. For each specific application, preparatory work for the use of BEAMES is needed. At the moment, BEAMES is designed for Residential Buildings, but in the future it could be adapted to any other specific building category (e.g., hotels, offices, schools, sport, etc.). BEAMES can also be adapted to satisfy particular customers' requirements (e.g. heating, cooling, power, money, environmental features, safety, maintenance, etc.).

The basic methodology could also be applied to produce a tool for the environmental auditing and management of buildings. The preparatory work for each specific application requires:
— the adaptation of the Artificial Neural Network;
— the production of a dedicated database of "reference cases" with which the Neural Network has to be "trained" (this corresponds to loading into the Neural Network the basic knowledge embedded in the reference cases).

System Identification

The first Competition on the application of System Identification techniques for the assessment of thermal characteristic data from buildings and building components was evaluated and published in a book /1/. The success of this competition led to the organisation of a second one in 1996 including a benchmark on simulated and experimentally obtained data series. The objective is to set up a comparison between alternative techniques and to clarify particular problems of system identification applied to the thermal performance of buildings.

Thermal Performance of Buildings and Building Components

An important contribution has also been given to the Working Groups of CEN TC89, which deal with the Thermal Performance of Buildings and Building Components. The input to WG 8 on Thermal Test Methods deals with dynamic analysis techniques and is a part of a standard that is now under the voting enquiry.

Thermal aspects of photovoltaic technology integration in Buildings

A pilot project was carried out in collaboration with ESRU, University of Strathclyde, Glasgow and the KTH, Royal Institute for Technology, Sweden on modelling and simulation of the thermal energy distribution of PV hybrid building components. The results from this work were presented at the 13th European Photovoltaic Solar Energy Conference in Nice.

Reference:

/1/ System Identification applied to building performance data, Edited by J.J. Bloem, EUR Report 15885 EN - 1994

NUCLEAR SAFETY AND SAFEGUARDS

Fission Reactor Safety

As a result of the approval of the 1995-1998 IV Framework programme, the ISEI activity on Probabilistic Safety Assessment (PSA) has been oriented towards severe accident-probabilistic studies. The work is aimed at harmonising risk assessment methods, by benchmarking different approaches and by networking national researches on critical aspects of PSA, such as the use of Expert Judgement (EJ), human factors modelling and assessment, statistical models and methods for knowledge extraction from operating experience. The whole activity will contribute to the improvement of Probabilistic Safety Assessment (PSA) methodologies and to the emergence of a consensus on their implementation in safety assessment and control of Nuclear Power Plants.

The research projects carried out in 1995, together with the established collaborations, are detailed in the next four sections:
— Expert Judgement in PSA
— Human Factors and Dynamic Reliability
— Data Analysis of Operating Experience
— PSA-STARS.

Expert Judgement in PSA

It is widely recognised that the demand for the use of engineering judgement at every level of the PSA analysis is mainly due to the complexity of involved phenomena in severe accidents (Level-2 PSA) and to the scarcity of data on, e.g., component failures and human errors. Expertise from many different fields (fluid-dynamics, geology, seismology, structural analyses, economy, medicine, etc.) is required to make up for the lack of consolidated knowledge. Despite the methodological advancements of recent years, the requirements of consistency, completeness, repeatability and defendability of the PSA analysis are strongly dependent on how this expertise is integrated into the overall risk assessment process. An activity on Expert Judgement in PSA has been initiated with the aim of improving the identification

and investigation of the above aspects and encouraging the use of proper analysis tools through the European Union. Figure 2.7. shows in a flow chart a typical structured expert judgement process. The project on Expert Judgement in PSA focuses on a number of tasks:
— the organisation, running and documentation of an European Benchmark Exercise on Expert Judgement techniques applied with reference to level 2 PSA;
— the collection and synthesis of information on the use of EJ in Probabilistic Safety Assessment;
— the development and application of a new approach to Expert Judgement in PSA based on knowledge engineering techniques.
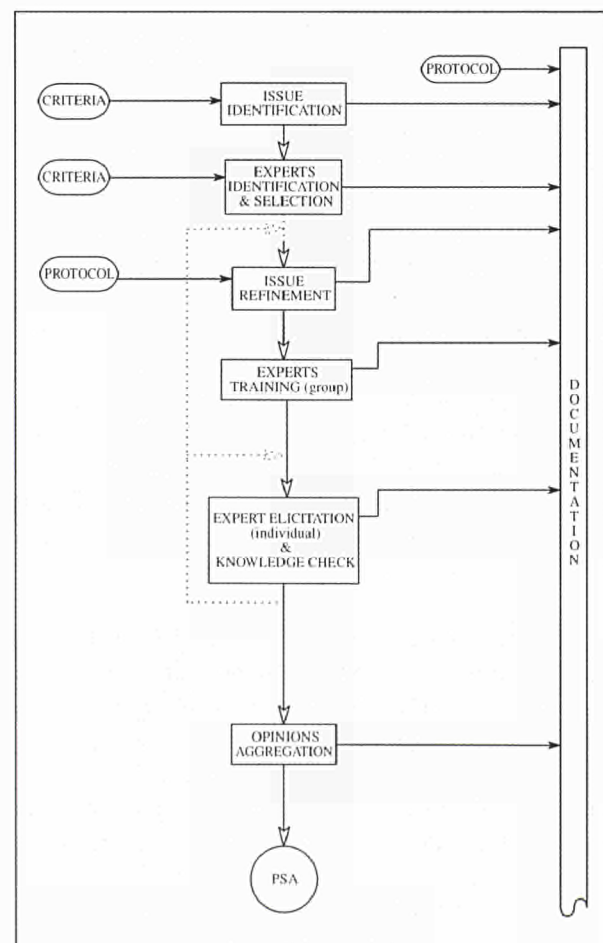

Fig. 2.7 Typical framework for structured Expert Judgement process in PSA

The first phase of the benchmark (1995-1996) will address the problem of parameter estimation and will be performed on the reference experiment test L21 test of the JRC facility FARO (Fuel melt And Release Oven) for fuel coolant interaction studies, adopted as a reference experiment.

JRC will also participate at the benchmark exercise with domain experts from the FARO facility. For each of the selected parameters of the experiment, the different Expert Judgement methodologies to be benchmarked will provide three quantiles (the 5th, the 50th and 95th). The comparison of the EJ approaches will be performed according to "internal" (scrutability, legal defensibility etc.) and "external" criteria (comparison with experimental data). The second phase of the benchmark (1996-1997) will address the problem of the construction of an Accident Progression Event Tree (APET) of a reference plant.

In the course of the year 1995 the benchmark exercise on the use of expert judgement (EJ) in probabilistic safety assessment, level 2, has been fully designed and launched /1/. As a result of a workshop held in Ispra in January 1995 /3/ a network of European institutions, active in the field of level 2 PSA, has been created and reference material has been collected on the use of expert judgement in Europe. The research network has successfully applied for a concerted action in the area of severe accidents. The action will start in 1996 and will involve ten institutions (NNC-UK, STUK-SF, GRS-D, AVN-B, UNESA-E, FGUPM-E, HSK-CH, JRC, NCSR-GR, ENEL-I) A second workshop on Expert Judgement was held in October to discuss the Expert Judgement methodologies to be benchmarked and to select the reference experiment /4/.

To complete the survey on the use of EJ in PSA, a specific questionnaire has been designed and delivered to about 50 institutions including industries, research laboratories, regulators, universities, etc. The questionnaire is organised in such a way to assess the degree of engineering judgement in all the main typical steps of a PSA of level 2 (including level-1), and to point out the areas in which formal expert judgement is actually employed. The analysis of the answers to the questionnaire will provide a unique snapshot of the use of EJ in current PSA throughout the world.

As specific research contribution of JRC to the Expert Judgement project the requirements for a new EJ methodology for PSA based on knowledge engineering techniques have been preliminary defined.

References:

/1/ Cojazzi G., Pinola L., Sardella R., (1995), Benchmark Exercise on Expert Judgment Techniques in PSA level2-Workplan, ISEI/IE 2938/95 WP.

/2/ Pinola L., Sardella R., Cojazzi G., (1995), Expert Judgment in PSA level 1 & 2 Questionnaire, ISEI/IE 2967/95 WP.

/3/ Cojazzi G., Minutes of the mini workshop for launching a BE on EJ in PSA, ISEI/IE 3053/95 WP.

/4/ Cojazzi G., Benchmark Exercise on Expert Judgment Techniques in PSA Level 2, Minutes of the October 5/6 Meeting JRC-ISPRA, ISEI/IE 3074/95 WP.

Human Factors and Dynamic Reliability

The thorough and accurate performance of the Human Factor (HF) analysis is an essential contributor for the development of a sound *design*, *safety assessment* and *management* of any highly developed technological system /2/3/4/. In particular, the HF issue affects three main elements of the configuration of such type of systems, namely: the inclusion of *automation* in the control loop, the *supervisory role* of the operator and the *dynamic nature* of all Human-Machine Interactions (HMI) and Human-Human Interactions (HHI). These three elements are strongly interconnected and interdependent. They all require a special focus on the analysis of the cognitive and decisional processes that lead to the actions and to strategic choices.

Nowadays, the further study of HF needs to be oriented towards the three specific types of human subjects, namely:
— maintenance personnel;
— control operators
— management and organisational structure.

In the domain of Nuclear Reactor Safety, these issues are particularly important and a methodology has been developed at JRC in order to tackle them. The method being developed at JRC is named HERMES for Human Error Reliability Method for Event
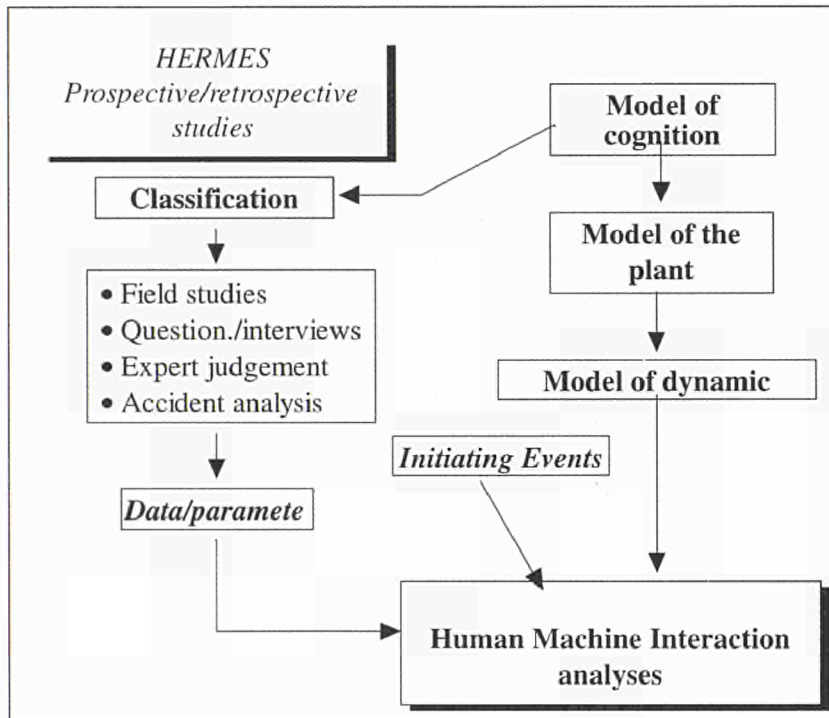
Fig. 2.8 The HERMES framework for Human Machine Interaction.

of studying the human-machine interaction in presence of false alarms. The behaviour of the operator is affected by this external event and may result in an erroneous diagnosis and in the performance of an inappropriate procedure.

Figure 2.9 shows a typical response generated by HERMES. It represents the calculated mass flows to the 4 Steam Generators (SG) of a PWR Nuclear Power Plant vs. time, as the result of the plant dynamics and of the regulation actions carried out by the operator, during an accident of loss of main feedwater flow combined with a false alarm. It can be observed that the mass

Sequences. The HERMES methodology, schematised as in figure 2.8, can be applied for prospective and retrospective type of studies.

The classification scheme, based on the model of cognition, guides the field studies, the development of questionnaires and interviews, the extraction of expert judgement, and the examination of accidents/ incidents, with the aim of estimating data and parameters to be included in the analyses. A series of initiating events, selected by the analyst in accordance with the objective of the safety study, triggers the whole set of sequences. These are governed by the model of dynamic interaction, which is based on the DYLAM method, already developed at ISEI /1/ and fully exploited in the HERMES approach. By means of DYLAM the reliability analysis of the human machine interaction and the physical behaviour of the system are fully coupled.

In the course of 1995 the methodology has been applied to a number of study cases, both in the domain of Reactor Safety and Aviation Transport Safety /5/. As an example, the analysis of accidents with external event can be performed with the aim

flow to SG1 rapidly becomes negative, as the water actually flows out of the steam generator due to the loss of flow. The mass flow to SG2 is set to 0 (SG2 isolation), just before 400 seconds, due to the error of diagnosis and it is never re-established. The mass flows to SG3 and SG4 are regulated at too low values between 400 and 800 seconds. After 840 seconds as a consequence of a recovery action the system is regulated according to the appropriate procedure.
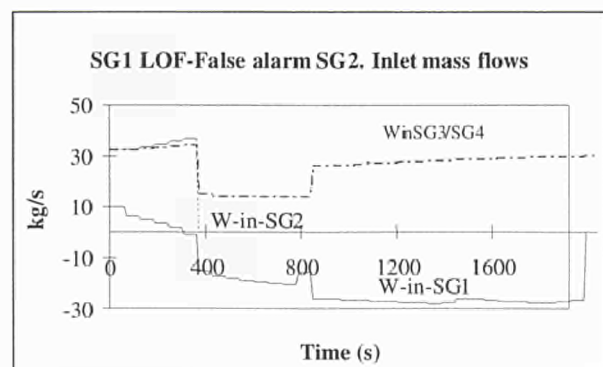

Fig. 2.9 Mass flows vs. time

References:

/1/ Cojazzi G., Cacciabue P.C., Parisi P., (1993), DYLAM-3, A Dynamic Methodology for Reliability Analysis and Consequences Evaluation in Industrial Plants, Theory and How to Use, Commission of the European Communities, EURATOM Report EUR 15265 EN.

/2/ Cacciabue P.C., (1995a). Human Factors. In H. Procaccia and J-J Raffoux (Eds) Guidebook on the effective use of safety and reliability data. pp. 309-319, ESREDA Series on Statistics, ISBN 2-9509092-1-3, Paris, France

/3/ Cacciabue P.C., (1995b). Error Assessment in Man-Machine Systems. In A. Kent and J.G. Williams (Eds) Encyclopedia of Computer Science and Technology. Volume 33, Supplement 18. pp. 113-135. ISBN 0-8247-2286-8. M. Dekker, Inc. New York.

/4/ Cacciabue P.C., (1995c). The Man in the Loop. SMiRT-13, Post-Conference Seminar on Current Issues in Probabilistic Safety Assessment, Gramado, Brazil, 21-22 August 1995. Reliability Engineering and System Safety

/5/ Cacciabue P.C., Cojazzi G., (1995). An integrated simulation approach for the analysis of pilot-aeroplane interaction. Control Engineering Practice, 3, 2, pp.257-266.

/6/ Cacciabue P.C., Cojazzi G., Parisi, P. (1996). A Dynamic HRA Method Based on a Taxonomy and a Cognitive Simulation Model. International Conference on Probabilistic Safety Assessment and Management, ESREL '96-PSAM III, Crete, Greece, 24-28 June 1996.

Data Analysis of Operating Experience

EIREDA volume 2, the European Industry Reliability Data Bank /1/ has been compiled, co-authored and published in collaboration with ELECTRICITE de FRANCE (EdF). The book presents Bayesian point and interval estimates for failure rates and probabilities of failure on demand for components entering in PSA level-1 studies. The effort has been made to include estimates published in the open literature but most estimates included were obtained from raw data stored in EdF's databases and on the assumption of homogeneity, no ageing and a conjugate prior. The book provides extensive methodological appendices which have been used also for teaching the essentials of Bayesian estimation of reliability parameters to practising engineers. The book has served a need of European Industry; it is already out of stock and a second printing is currently under way.

Reference:

/1/ Procaccia, H. Aufort, P. and Arsenis, S. P. (1995). European Industry Reliability Data Bank Data EIREDA. Paris, SFER.

PSA-STARS

As a result of the new research orientation within the IV framework programme, the PSA-STARS project, initiated in 1994 has been reshaped and carried out only through the ongoing collaboration between JRC-ISEI and TÜV (Technischer Überwachungs-Verein). The fault tree algorithms of the ISPRA-FTA (Fault Tree Analyser) contained in STARS have been critically reviewed in order to arrive at the specifications of the characteristics of a Fault Tree analyser for NPP applications /1/. In particular new features will be added to the code in order to properly treat time dependencies and staggered testing policies. A pilot application to the study of functional dependencies and CCF has been carried out /2/. A literature survey on the existing tools and methods for automated construction of Fault Trees and Event Trees have been performed /3/.

References:

/1/ Contini S., Cojazzi G., Sardella R., (1995), Technical Specifications and Algorithms to Adapt Ispra-FTA for Nuclear Applications, EC-JRC-ISEI, May 1995, Technical Note No.I.95.62.

/2/ Cojazzi G., Mauri G., Sardella R., (1995), The treatment of Physical dependencies and CCFs within the STARS environment: methodological framework and applications. PSA'95 Int. Conf on Probabilistic Safety Assessment Methodology and Applications, November 26-30, 1995, Seoul Korea.

/3/ Sardella R., (1995). A Review of Knowledge-based Systems for Fault Tree/Event Tree Construction, EC-JRC-ISEI, February 1995, Technical Note No. I.95.21.

Concerted action BE-EJTs: Benchmark Exercise on Expert Judgement Techniques in PSA level 2

In order to reinforce the project on expert judgement launched by the JRC, a successful concerted action has been started. within the European Commission, Nuclear Fission Safety Programme. The objective of this action is, to constitute a framework for the benchmarking of different structured Expert Judgement (EJ) techniques (N FI4S-CT95-0012). The participants to this Concerted Action come from industry, public authorities and research organisations:
- Joint Research Centre - Institute for Systems Engineering and Informatics (IT)
- FGUPM, Fundacion General de la Universidad Politecnica de Madrid (ES)
- GRS, Gesellschaft für Anlagen und Reaktorsicherheit (DE)

- STUK, Finnish Centre for Radiation and Nuclear Safety (FI)
- NNC Ltd. (GB)
- ENEL, Ente Nazionale Energia Elettrica (IT)
- AIB-VINÇOTTE NUCLEAR (BE)
- UNESA, Unidad Electrica, S.A. (ES)
- National Center for Scientific Research "DEMOKRITOS",INSTITUTE OF NUCLEAR TECHNOLOGY RADIATION PROTECTION (INT-RP) (GR)
- HSK, Hauptabteilung für die Sicherheit der Kernanlagen (CH)

The JRC will organise the Benchmark Exercise (BE) acting as scientific co-ordinator, while AIB-VINÇOTTE NUCLEAR, will be the financial co-ordinator of the project. All the participants of the concerted action will provide the participation at the Peer Review Group charged of the evaluation of the methodologies (results and documentation).

The objectives of the on going BE have been fixed by the participating institutions as:
- The documentation of the different methods and techniques for the use of EJ actually adopted by European PSA practitioners.
- The benchmarking of a set of EJ approaches differing in level of effort.
- The analysis of the effectiveness of these different EJ methodologies in increasing the consistency, completeness, repeatability, scrutability and defensibility of the PSA study.

Nuclear Safeguards

Distributed surveillance system

In large nuclear facilities safeguards surveillance is based on recording video images from many TV cameras in different locations. Conventional surveillance systems collect video data in a central recording and processing station. Because of real-time constraints the maximal number of cameras is limited to 16. A new concept of surveillance for safeguards is based on a distributed system comprising intelligent cameras with local processing capability, a real-time field bus and a host computer.

The intelligent cameras, including a multiple framestore and microprocessor, can detect a relevant event and transmit a short digital video sequence over the field bus to the host computer. The cameras are commercially available devices used in machine vision inspection. Different existing field bus standards (LON, FIP, Profibus) have been investigated and the WorldFIP standard has been adopted for the application. This year the work focused on setting up a basic demonstration system in the laboratory. The software development dealt mainly with the capture of a video sequence in the camera, the segmentation and transmission of a digital image over the FIP field bus as well as the review of stored alarm pictures in the host computer.

Mobile Robotics for the Remote Verification of Fissile Materials

The objective of this project is to apply mobile robotics technologies to the remote verification of advanced storage areas of fissile materials, of difficult access to inspectors. The system consists of two main components: a vehicle carrying a manipulator arm and sensors on board, and the system's operator console. Particular importance was given to human-computer interaction and to Safeguards orientations.

Both the system hardware and software architectures have been thoroughly tested in recent years, and can be considered stable. Moreover, the tools developed for manual control have matured and can be considered finalised, i.e., no major changes should be necessary with the current technology, i.e., system's architecture, on-board equipment (e.g., computer controlled pan and tilt units, motorised zoom and focus lenses) and sensors (e.g., TV cameras, ultrasonic devices, laser range finder). The work concentrated thus along the following lines:
- increase the computing power available aboard the mobile platform;
- improve the server of communications between the operator's console and the remote system;
- investigate the utility of the on-board sensors for high level tasks such as autonomous navigation and remote surveillance;
- investigate innovative control schemes allowing for co-operative control of different robotics mechanisms.

The increase of the computing power aboard the mobile platform is justified by the computational requirements of some of the tasks such as local navigation. Indeed, a neural network must be computed in real-time for mapping data from the ultra-sound sensors into perception maps of the free space around the vehicle /1/2/. It was

decided to upgrade gradually the existing computer boards to 68040 ones. This change required some major changes in what concerns software development.

New Communications Server

Several years of experience with the communications server /3/ confirmed its utility not only for rationalising the communications between the console and the remote system, but also as a major component within the system's software architecture. New hardware and software components have justified the rewriting of the communication server making it more adaptable to changes, and more flexible in terms of its utilisation. New commands have been included, and an effort was made to divide the communications server into separate, independent modules. This structure allows for flexible and easy to use system hardware and software configuration /4,5/.

Navigation

"Where am I" is a question that all mobile robots should be able to answer 6/. Indeed, the answer to the position localisation problem is not straightforward since it depends strongly on the type of sensors aboard the robot, the *a priori* knowledge about the environment, and the infrastructures provided (e.g., radio beacons or artificial landmarks). Two methods were investigated, one based on a simple active vision algorithm /7/, the second based on the analysis of distance profiles /8/ . These two methods rely upon sensors aboard the robot: the surveillance cameras and the laser range finder respectively, both of them mounted on top of computer controlled pan and tilt units. Both methods share a common constraint in the sense that there should not be any sort of preparation or modification to the environment prior to vehicle navigation (including localisation) tasks. This aspect is most important considering that Safeguards inspections should not interfere with routine plant operations.

Vision Based Approach To Position Localisation

This work concentrated on the use of active vision techniques (i.e., those involving a computer controlled change of the camera parameters, e.g., orientation or focal length), to determine the pose (i.e., localisation and orientation) of a robot based on natural landmarks. The ultimate objective would be the use of on-board cameras both for surveillance and for localisation purposes. The algorithms are based on the trigonometry between the observer and the landmarks. Theoretical studies were done to derive the necessary equations and a statistical analysis performed to evaluate the sensitivity of the algorithms to noise and unreliable data. Later, a practical system was implemented and experiments supported the theoretical findings. It was found that:
— the angular spacing between landmarks should be kept as large as possible for improved accuracy, a minimum angle of 30° between landmarks is necessary;
— there must be a compromise for the choice of the focal length of the camera lens trading off the pose estimation frequency and the localisation and orientation accuracy. Indeed, wide angle lenses view more of a scene, and require less mechanical pan movements to cover all the necessary landmarks. On the other hand, larger focal lengths increase the detail with which a scene is observed, and consequently increase the positional accuracy associated to the landmarks. Figure 2.10 shows a screen shot of the landmark

Fig. 2.10 Screen shot of the matching procedure in action

matching procedure in action. The matching procedure is based on a 1D normalised correlation. A pan and tilt unit moves the camera when landmarks are found to fall outside the image. This normally happens when the robot moves.

Localisation Using Laser Range Data

Considering that the localisation problem is finding the distance co-ordinates of a mobile robot within a global co-ordinate frame, it was decided to sense the environment with a laser range finder. This sensor provides direct distance measurements based on the time of flight of a laser pulse. The proposed technique chooses two vertical edges (from the *a priori* known environment map) towards which a laser scan is directed. The distance profiles obtained are then analysed and the vertical edges (landmarks) found with good accuracy. From the knowledge of these two landmarks and their distance, a triangulation procedure is invoked and the robot's pose, i.e., position and orientation, found. The technique assumes that a rough estimate of the robot's position and orientation are known. If this is not the case, a 360° scan may be performed, and the complete range profile matched with the environment map.

This localisation approach is based on the recognition of natural landmarks and although requiring feature extraction is not a feature based approach.

Figure 2.11. show two pairs of vertical edges that can be chosen as landmarks for vehicle localisation. The accuracy of the algorithm changes accordingly. Future work will integrate the localisation procedure with existing navigation modules aiming at real-time localisation while the vehicle is moving.

Interactive Mobile Surveillance System

A mobile robot equipped with two video cameras mounted on top of computer controlled pan-and-tilt units was assembled for remote interactive surveillance tasks /9,10/. The cameras have computer controlled motorised zoom and focus lens allowing the operator to get the best view of the scene being inspected. The operator can use the mobility of the robot and steer it to the next scene of interest.

Vision Control for the Remote Operation of a Manipulator Arm

The objective of the work was the investigation of computer vision techniques as a means of assisting an operator controlling a remote manipulator arm aboard a mobile platform. The aim is not to replace the operator but, rather, make use of onboard sensors to relieve the operator from continuous manual control in the execution of some basic tasks. The specific task chosen for the current application was to press an electrical power switch present in
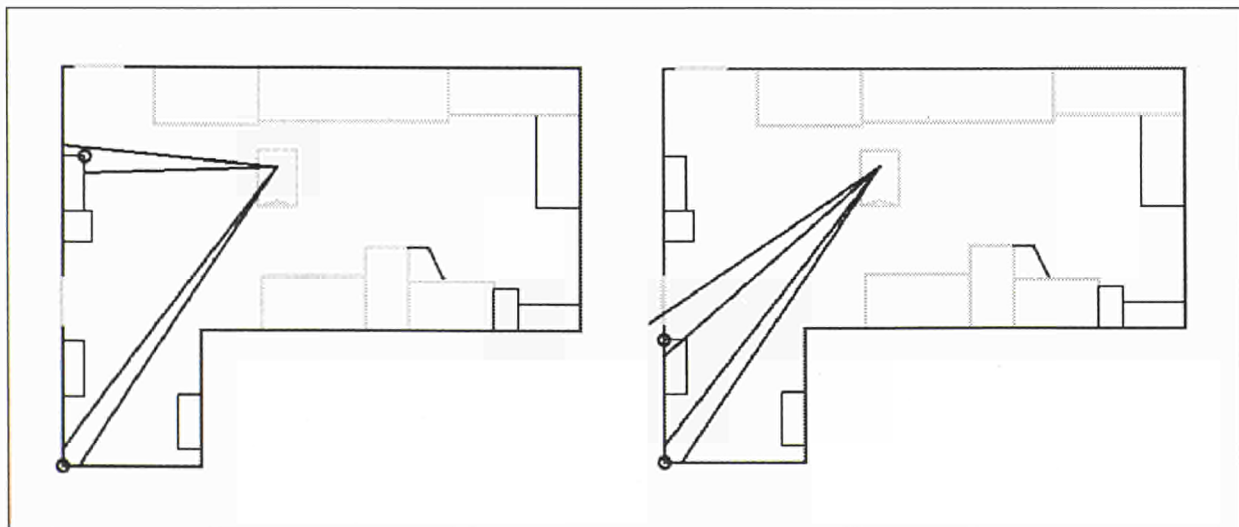

Fig. 2.11 Two pairs of vertical edges that can be chosen as landmarks for vehicle localisation

the mobile platform's environment and capable of being reached by the manipulator arm. The operational approach adopted is totally geometric. The most crucial parameters involved are: the camera-target distance (depth) and the relative attitude (pose). Both unknowns are retrieved based on the analysis of the contour of the target image, done by means of a B-splines based snakes technique.
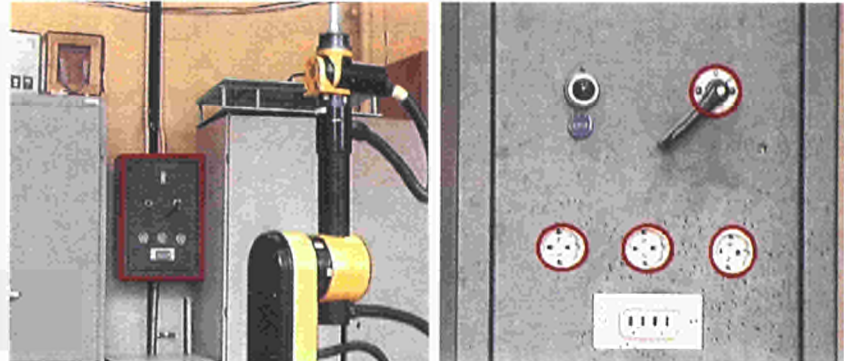

Fig. 2.12 Automatic detection of an electrical switch box, and of a connector socket.

It is concluded that computer vision techniques can be useful when the problem is well formulated. Indeed, it was possible to press the target object with a precision of about 2-3 mm, which is enough for that application /11/12/. It is believed that it would be rather stressful for an operator, even with very sophisticated human computer interaction techniques, to achieve such a precision.

Object Search using Compound Functions

One of the most time consuming tasks in remote inspection tasks, is object search, i.e., locating *a priori* known objects in a scene, irrespectively of translation, rotation and size. The approach of this investigation has been to define the appearance of objects by means of a compound function made up of a set of thousands of sub-functions, each one describing an elementary object characteristic. Having described an object in this way, stochastic search techniques can be used to speed-up the location of an object. Thousands of independent agents are asynchronously and randomly "thrown" into the image search space, each one testing a particular object sub-function (i.e., hypothesis testing). Once an agent is successful in its search, this information is passed to the next generation of agents, who tend to cluster around the successful ones and test other elementary features. It is then possible to efficiently discard incorrect beliefs. An object can then be located in the image search space in a fast and efficient way. At this stage a dedicated algorithm can make a refined analysis of the object in question.

During this work it was possible to extend the applicability of stochastic search methods and provide a more rigorous, statistically based halting condition capable of deciding when was an object really located for a given degree of confidence /13/. Figure 2.12 shows the automatic detection of an electrical switch box, and of a connector socket.

Co-operation Between Robotics Mechanisms

Robotics systems are generally systems with many degrees of freedom each one associated to different types of motion constraints.
The classical approach to dealing with such systems is by having centralised control. This approach has two drawbacks:
— the algorithms are computationally heavy; because the system has many degrees of freedom;
— the system movements are constrained by the environment. Information about the environment must come from the system's own sources.
During the past year, ISEI has worked on novel control mechanisms based on co-operation techniques. A complex system can be normally divided as an assembly of simpler sub-systems.
The co-operation approach that is being investigated relies upon:
the consideration that each sub-system is a separate robotic mechanism, with its own independent controller;
feedback and feedforward information between the robotic devices;
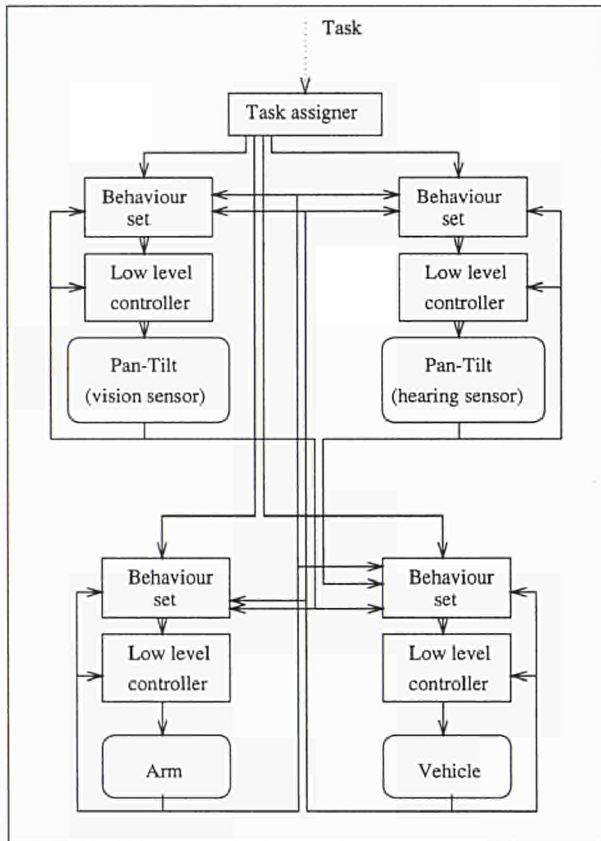each robotic device is equipped with a set of capabilities (aka behaviours), adapted to the mission

Fig. 2.13 Topology used for the co-operation between a mobile robot and a manipulator arm.

Remote Surveillance

Remote surveillance is a fast developing application area. There is an increased perception of what can be done using state of the art technology in digital communication networks, active sensing for remote equipment, human-computer interfacing and interaction, data compression, encryption and authentication for securing privacy and confidentiality. Remote surveillance puts a strong emphasis on systems integration, considering that most of the necessary technologies already exist. In many cases the discussion is how to devide tasks between the different system's components. One of the unsolved questions is whether one should have a centralised decision station or distribute processing and decisions throughout the network. The answer to these questions is not straightforward and should consider the application and all the factors involved, namely the reliability and bandwidth of a network, the level of confidentiality required, the level of interactivity required, the expected intervention time in case of alarm, the required operator's proficiency, etc.

Following the work from previous years, there is a considerable expertise in the technologies required for remote surveillance. Research activities concentrated in both the human computer interaction aspects required for simple tasks such as interactive

to be executed. Behaviours are triggered by conditions involving the feedback information, including sensory data.

The study of co-operation techniques contains the synthesis of different behaviours, the topology of the different interconnections, and the questions related to the controllability of the global system.
Figure 2.13. illustrates the topology used for the co-operation between a mobile robot and a manipulator arm.
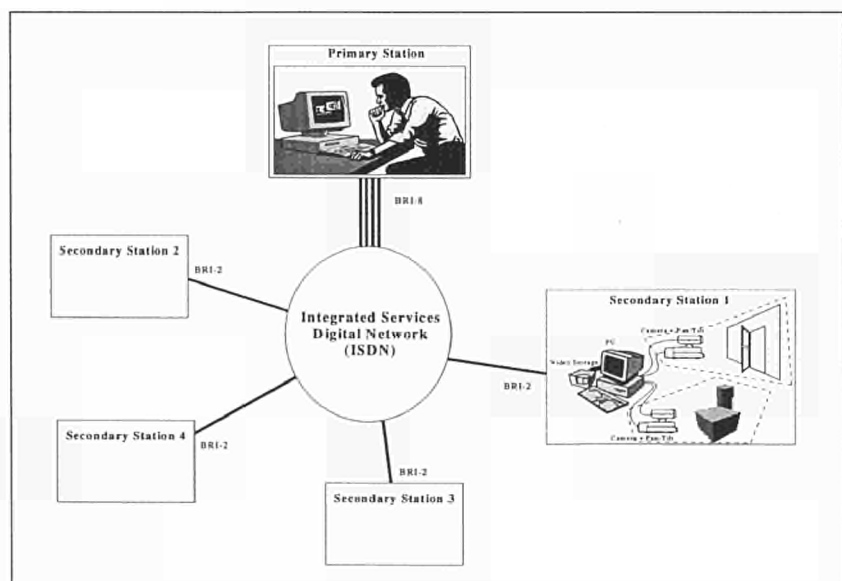

Fig. 2.14 Global architecture for an ISDN based remote surveillance system.

surveillance or to remote manipulation, as well as in bridging the communication link between the remote surveillance equipment and the operator's station using public digital networks.

Remote Video Surveillance
over ISDN

The aim of this project is to explore the potentialities of public digital communication networks, in particular ISDN (Integrated Service Digital Network), for remote video surveillance (see Figure 2.14). Different aspects should be considered in what concerns video compression standards (e.g., H261, M-JPEG or MPEG), encryption and hardware accelerators. The aim is to have a master surveillance station, from where an operator can interrogate several remotely located secondary surveillance stations. At any time the operator can dial a specific station and receive in "real-time" live (or quasi-live) images of the surveillance cameras connected to the station. The cameras have computer controlled zoom and focus lenses and are mounted on top of computer controlled pan-and-tilt units. It is then possible for the operator to have remote interactive control over the video cameras. If the images from the surveillance cameras go through a local scene change detection application, it is possible for the secondary stations to call the master station, alert the operator and transmit the sequence of still images that originated the alarm. The operator can then use all the system's remote control possibilities and get a more detailed view of what is really happening.

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/10/ Gonçalves J.G.M., Nunes J., Santos V.-"An Interactive Remote Surveillance System", Proc. 17th ESARDA Symposium on Safeguards and Nuclear Material Management, Aachen, May 1995.

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/13/ Grech-Cini H. - "Compound Functions in Computer Vision, and Methods for their Efficient Utilisation", JRC Technical Note (to be published in 1996).

Development of new surveillance systems

In the Advanced Storage Area, storage cells for plutonium cans were equipped with several kinds of sensors for the monitoring and the containment of the nuclear material. Surveillance systems, CAVIS and Heat Flow Parabola, were also installed for the surveillance of the storage area.

A new surveillance system, SYCLOP (System of control for locations and objects by parabola) based on *heat flow technology*, has been developed in LaSCo: (Laboratory for Surveillance and Containment). This technology represents a new low cost approach, which could be complementary or replace some other monitoring techniques. This passive surveillance system concentrates the thermal radiation of environment thanks to a parabolic reflector. Every modification of the thermal equilibrium in the controlled zone can be detected with a heat flow sensor. No lenses are necessary. There is reduced sensitivity to convection hence no encapsulation is necessary. As a result, the spectral density of the absorbed or emitted radiation of the sensor is not disturbed.

The potential application of such a system is the surveillance of locations and objects: all objects which absolute temperatures are over 0°K emit infrared radiation. Infrared radiation are the electromagnetic waves in the wavelength region from

0.75 mm to 1000 mm between visible light and microwave. The heat flow sensor, giving a real information of the energetic lack between a system and its environment, is ideal to analyse heat losses. Every variation in temperature is caused by gains and losses of energy. The e.m.f. generated by the heat flow sensor allows it to anticipate variations in temperature of its support. Furthermore, radiative exchanges in the case of human intrusion in the surveyed area are so important that the sensor's structure has been modified to obtain an e.m.f. proportional only to radiant exchanges.

The idea has been *to detect, with a sensor and a thermal concentrator, any modification of the thermal equilibrium in a well defined volume caused by a human intrusion in a controlled zone* (Figure 2.15.) not only to detect the infrared radiation emitted by a human body at short range (1 m). The first application for this new detector is the surveillance of a simulated Pu storage in the LaSCo laboratory at ISEI. (Figure 2.16.)

This detector can be adjusted according to the volume of the protected zone.(in other words according to the distance and the angle of the parabola).

A second application for this "parabolic reflector-heat flow sensor" surveillance system is as a new way of monitoring Pu storage (individual containers). Using the same technology as in the first application, a defined zone of a room can remotely be controlled
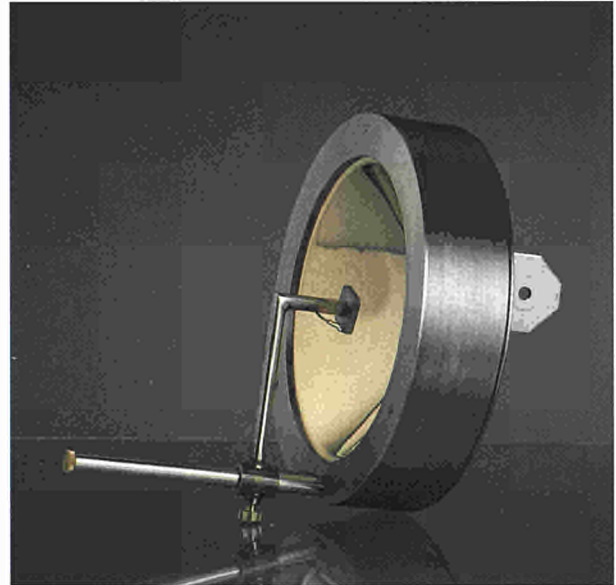

Fig. 2.15 View of the SYCLOP detector

with the possibility to move and work in other parts of the same room. This technology can thus be used to monitor small areas and not only large areas as corridors in entire rooms. So, the thermal concentrator is selected to control reduced areas where for instance a single simulated Pu container is placed. An experimental study has confirmed the forecasts from classical modelling of parabolic mirrors. In practice, a sensor's 30mV/W sensitivity allows to monitor a container at a distance of five meters without interference from the environment. (such distance can be increased to 12 m or more
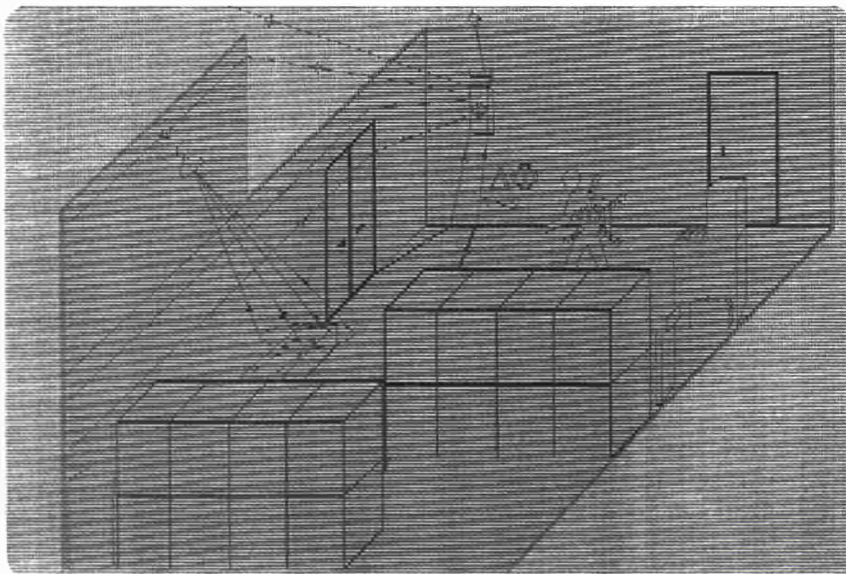

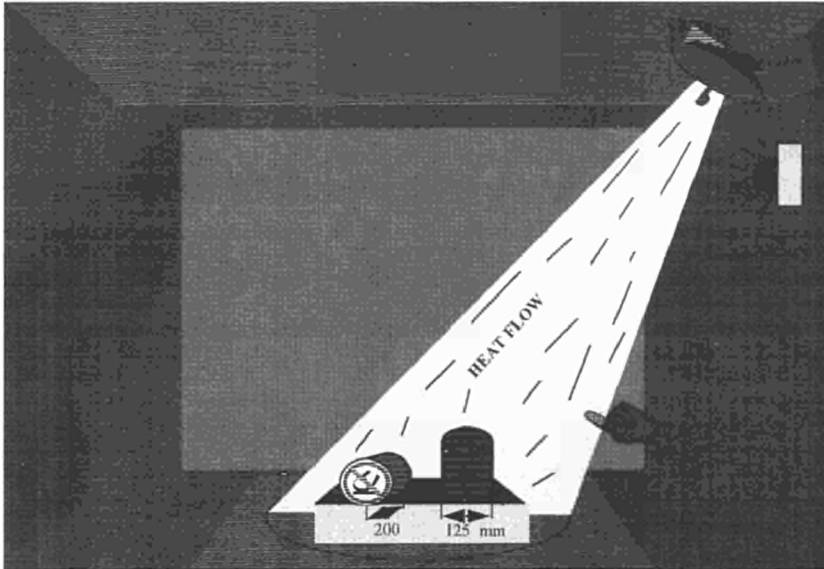Fig. 2.16 Layout of areas protected by SYCLOP

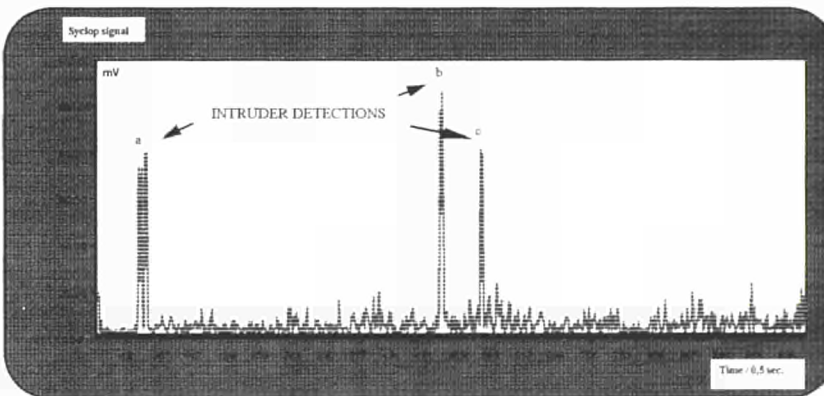Fig. 2.17 Surveillance of individual containers by SYCLOP

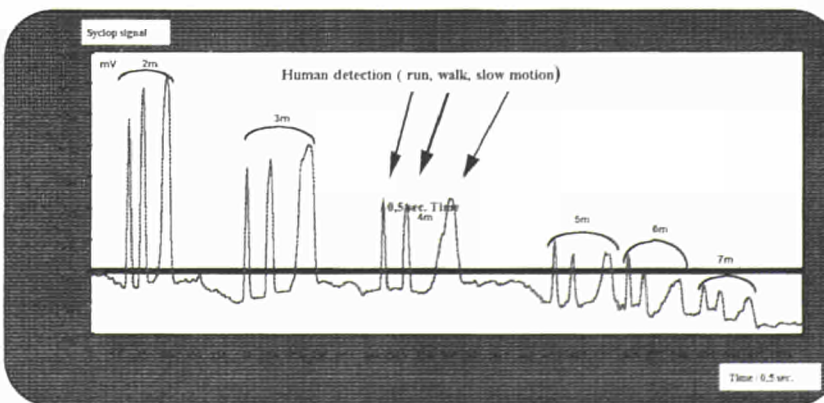Fig. 2.18 Signal deliver by SYCLOP watching a monitored zone

Fig. 2.19 Various intruder detection simulated at various distances and in different ways in a corridor monitored by SYCLOP

with a different configuration) (Figure 2.17.). To characterise the system's performances, subjective notions are needed to model a Pu container. A stainless steel container, regulated in temperature (from 40°C to 60° C) , has been used to characterise the sensitivity and the reliability of the system.

Figure 2.18. shows the stability of the signal delivered by SYCLOP watching a controlled zone. When an intruder enters a controlled zone, the thermal balance changes, causing a sudden signal variation (points a, b, and c in the figure 2.18.). It can set off an alarm when a threshold level has been crossed. Figure 2.19. shows the various intruder detection in a corridor controlled by SYCLOP. Intrusions were simulated at various distances and in different ways (Figure 2.19.). These two applications of this new system concern the monitoring domain. The association between a new thermal sensor and a parabolic reflector has specific advantages for a passive surveillance system. It is important to specify that this detection system is not based on infrared analysis. It is based on the modification of the thermal equilibrium in a controlled zone. The system's flexibility in adjusting and adapting to any environment, its innovative nature and its low cost should allow its use as a surveillance system for banks, and private home owners, and in agriculture and industry.

This SYCLOP surveillance system was patented by the JRC in December 1995. Patent No. LU-2488

Performance Assessment of Containment and Surveillance Devices and Systems

In the framework of the co-operation between JRC and the US Department of Energy, 500 multipurpose paper seals (see Figure 2.20.) were sent to T.E.M.P.E.S.T. laboratory (LaSCo testing facility), in order to be submitted to various tests to study the behaviour in terms of influence of temperature and humidity on colour modification, loss of adherence when placed under severe climatic conditions on various supports such as steel, wood, glass etc. The tests were conducted in a temperature range of -55°C to 70°C and at a humidity level of 93% at 40°C according to the various thermal and humidity IEC 68.X.X standards.

In another test paper seals were placed outside the laboratory for a duration of between 3 months and one year in order to study their behaviour under long term exposure to real atmospheric conditions. These conditions are continuously changing in terms of temperature, humidity, rain, solar radiation, rain acidity, pollution etc...
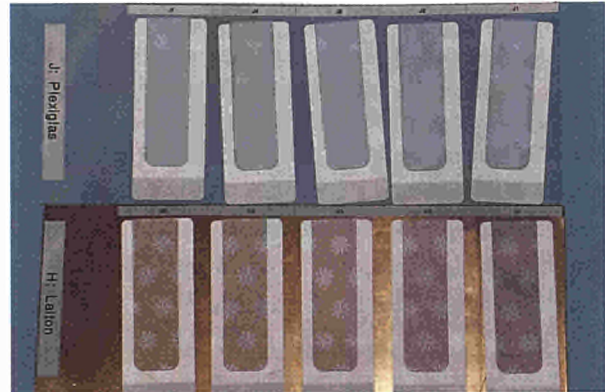

Fig. 2.20 View of five paper seals on their Plexiglas and brass support

Demonstration and development of procedures for proper use of containment and surveillance in specific applications

In the Advanced Storage Area, storage cells for plutonium cans were equipped with several kinds of sensors for the monitoring and the containment of the nuclear material. Surveillance systems, CAVIS and Heat Flow Parabola, were also installed for the surveillance of the storage area.

A first set of tests on the Horizontal Multisensor Module (Ho.M.M.), which is designed for monitoring of Pu cans using different sensors such as heat flow, weight etc., has been carried out. This version of module (Ho.M.M.1) is A.C. powered and two versions have been tested (Figure 2.21). The second generation of Ho.M.M. is battery powered. Alarms, state of health of the module are recorded on a memory block inside the module. The software for the programming and the downloading of data has been developed. Alarms can be interrogated by connecting a portable P.C. to the module.

Fig. 2.21 View of Ho.M.M. module with its data acquisition and processing unit

The tests to be carried on this type of module will be mainly oriented on the battery autonomy. The software designed and implemented on a portable unit for the calibration and routine surveillance of the Ho.M.M. modules have been upgraded with a sensor response module. Long term tests on the traditional sensors installed in the cells have started at the end of this year and will continue during 1996.

The tests on the prototype of Integrated System, running since early 1994, were done for all 1995. In the frame of the Remote Monitoring Project, the SANDIA laboratory have installed new sensors in the A.S.A. laboratory. In the next future a Ho.M.M. module installed in a storage cell will be incorporated in this project.

Seals and Identification Techniques

Based on experience recently gained in real conditions, the *SILab* Laboratory (Seals and Identification Techniques) has continued its activities on improving its Ultrasonic Seals Technology in all practical aspects. The efforts have focused on improving the existing technologies, already partially implemented on sites, as well as on considering and developing new potential applications, for instance: dedicated sealing systems for long term air storage or medium term underwater storage of spent fuel.

R & D on Sealing and Identification Techniques (Hardware and Software).

Research has continued into equipment used by inspectors to read seals. New hardware (cheaper, lighter and easier to operate), new software (more accurate, inspector friendly and faster), new database (to improve the data processing and management by inspector headquarters) have been proposed and tested.

In particular work was focused on reducing the size and improving handiness of the equipment carried by inspectors, and the study of the replacement of complete pieces of (ultrasonic) equipment by special ultrasonic/electronic boards directly installable into the slots of new generation laptop computers. This development has been a success and a new set of two boards was specified within mid 1995, based on commercial boards manufactured by a French specialist company (SOFRATEST). Its systematic testing and evaluation was also conducted in collaboration with a German company (R.M.T.). These boards installed in a robust portable computer could be demonstrated in several occasions along with a complete sealing system /1/. Then the study of a more compact solution based on one unique ultrasonic board installable into a "one slot only" (light) notebook computer was launched and a first prototype was released in November 1995 with practically the same features
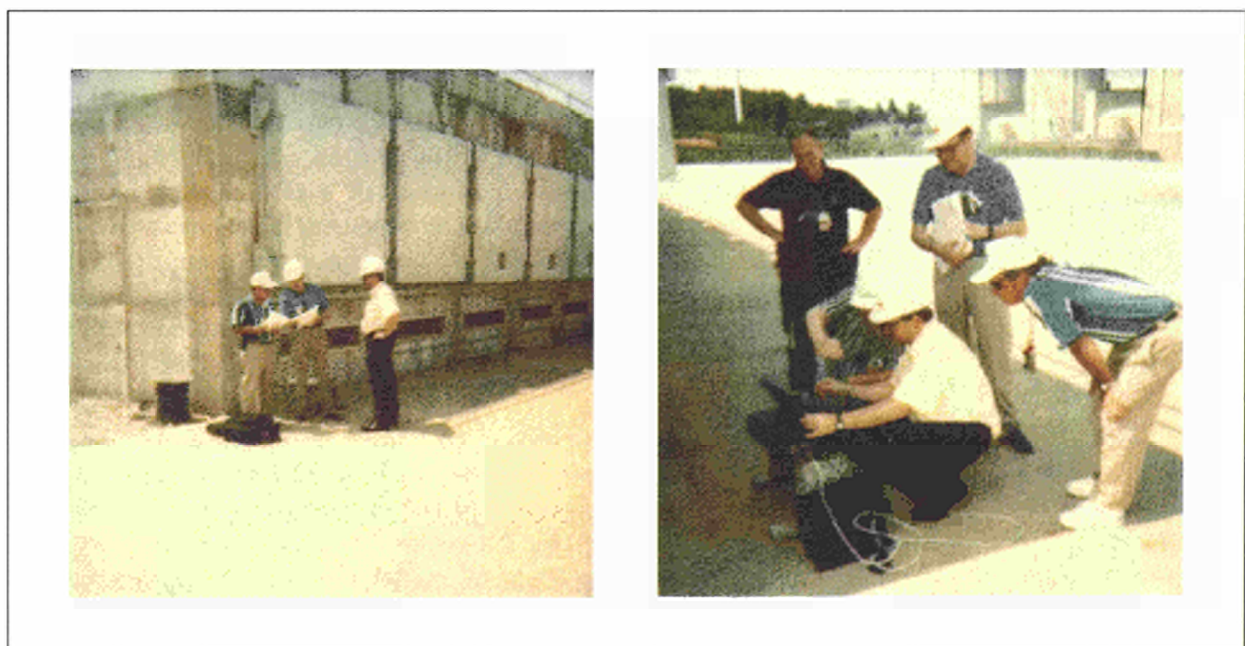

Fig. 2.22 Duke Power Company, Oconee Nuclear Station (South Carolina). Ispra staff demonstrating to Duke personnel the Portable Sealing System in front of a NUHOMS (Horizontal storage module for spent fuel).

installed on one unique board. The main result is that, from now on, operators carry and use one single instrument only in place of two while performing seals installation and/or verification.

*Studies on potential new applications
of the Sealing Systems*

The results as above have allowed to envisage various applications of the technology. The work consisted in evaluating how a sealing system could be adapted to the requirements and configuration of existing containment structures, and to propose solutions associated with engineering drawings. The proposal of various solutions has been greatly facilitated by the existence of a demonstrable portable "complete system" already tested and incorporating the essential of the recent "compact technology". Several demonstrations took place in the world, either in occasion of conferences or exhibitions /1/ or on a contractual basis. Among others, the following exploratory work has been conducted.

Demonstration for marketing purposes in the USA

A system derived from the one above was presented in the US at the DUKE storage facility of Oconee in South Carolina, indicating a potentiality for that technique for the safeguarding of dry air concrete storage (Figure 2.22). Preliminary evaluation has been done by ISEI, based on original drawings provided by the US Company Vectra and presented to the Power Reactor Duke company. A 'larger approach based on a study to evaluate the potential needs in the US for ISEI systems will be launched in 1996.

Demonstration for marketing purposes in France

On request of the French electricity board EdF, an approach has been made for the development of a special underwater "Sealed Locking Device" for PWR fuel assemblies. A prototype has been even manufactured at ISEI and loaned to EdF for internal evaluation purposes.

Reference:

/1/ B.C. d'Agraives, E.Mascetti, P. Tebaldi, J. Toornvliet, (SILab JRC-Ispra); B. Silber (R.M.T.); T. Hayakawa, T. Hosoma (P.N.C.), PRESENTATION OF A NEW PORTABLE ULTRASONIC SEALING SYSTEM FOR NUCLEAR CONTAINERS ESARDA 17th Annual Symposium, Aachen, 9-11 May 1995, p.687

Integration of Safeguards Systems

This activity comprises four main chapters, respectively dealing with: i) the Analysis of the Safeguards characteristics of the Nuclear Fuel Cycle and of the R&D Safeguards Activities in the EU, ii) the management of the ESARDA Association, iii) the development of statistical tools for Nuclear Material Balance Analysis and iv) the studies on volume and mass determination in liquids.

Fuel Cycle Analysis

The increasing contacts with the East European and the Former Soviet Union Countries has raised the need to analyse the development of the Fuel Cycle of these Countries. A thorough study of the fuel cycle has therefore been started with the support of the Russian Institute for Physics and Power Engineering (IPPE) at Obninsk.

The work covers the Russian Federation and the other countries that constituted the Former Soviet Union and the East European Countries having Soviet design reactors (Bulgaria, Hungary, the Czech Republic, Slovacchia and Finland).

The work focus is on those aspects relevant to safeguards.

The first two basic phases of the study are:
- definition of the characteristics of the various nuclear facilities (refining-conversion, enrichment, fuel fabrication, reactors, spent fuel storage, reprocessing, storage of U and Pu);
- identification of the flows of nuclear materials among facilities.

All this will constitute the necessary information for successive analysis evaluation. The characteristics of Soviet-design nuclear power plants, in particular the features of the fuel element types produced and used have been defined. The general features of the other fuel cycle facilities have been outlined. In parallel to data collection activity, the set-up of a data base to host these data has also been started. The work will continue during 1996.

Management of ESARDA

ESARDA day to day management is currently done by ISEI together with the organisation of its meetings, the publication of the Bulletin of the Association, the Secretariat of the Steering Committee, of the Scientific Council and Co-ordination Board, and of the Executive Committee.

In 1995, the Internal Rules of the Association were reformulated, in order to match the new structure created in 1995. They were printed and distributed within ESARDA.

In May 1995 a Symposium was organised in Aachen, Germany, in collaboration with the KFA Jülich. The proceedings were published. Two issues of the ESARDA Bulletin were published.

ISEI collaborated with other ESARDA Parties in defining the objectives and in setting up a new Working Group dealing with the Back-end of the Fuel Cycle, which started its operation at the end of 1995. The Institute also collaborated in defining and carrying out the preliminary organisation of three meetings to be held in 1996:
— Joint Meeting with the British Royal Society of Chemistry on the "Analytical Measurement and their Interpretation for Regulatory Purposes";
— Joint Meeting with the American Institute for Nuclear Materials Management on "Modern Science and Technology for Safeguards";
— Joint Meeting with the Russian Institute for Physics and Power Engineering on the co-operation with the CIS Countries in developing a Nuclear Material Accountancy and Control system.

Statistical tools

A software for the Statistical Analysis of Nuclear Material Balances (SAMBA) has been developed in view of its use in the Russian "Methodology and Training Centre" of Obninsk for the purpose of training Operators of Nuclear Facilities and Inspectors . This software runs on a PC computer in the WINDOWS environment. It can be operated either in the English language or in the Russian language (with Cyrillic characters); the computer environment shall however be English. A version for computer having a Russian environment will be developed in 1996.

Mass and Volume Measurements of Liquids

In February, a staff member of the Safeguards Unit was invited by the Japanese Nuclear Material Control Centre and by the JAERI to give lectures on "Data Interpretation and Evaluation in Mass and Volume Measurement". Lectures were given in Tokyo and Tokai Mura.
Activities were performed in collaboration with the TAME Laboratory, for developing models for

the interpretation of experimental results and perform data evaluation. Many experiments were conducted for testing thermal effects and aerostatic effects in volume measurement. Results were published at the 1995 ESARDA Symposium and at the 1995 INMM Meeting.

CONTROLLED THERMONUCLEAR FUSION

Controlled Thermonuclear Fusion

The Fusion activities at ISEI concerned critical aspects of Fusion plants safety, with the objective of evaluating feasibility and acceptability of Fusion Energy, in particular referring to:
— operational safety during maintenance by remote handling;
— structural integrity under plasma disruptions transients;
— passive safety behaviour of the reactor in post-accidental conditions;
— tools and methods for safety analyses and reliability assessment.

These activities, co-ordinated by the European NET team, are carried out in the frame of ITER design tasks and long-term studies tasks for the SEAFP (Safety and Environmental Assessment of Fusion Power) programme, in the areas of:
— Remote Handling Maintenance.
— Vessel, In-Vessel components.
— Safety and Environment.

Remote Handling Maintenance

The engineering support to the Remote Handling problems is provided by Computer Simulation and Experimental Validation on mock-ups, inside the Teleoperation and Robotics Laboratory TELEMAC, by means of an appropriate CAE system and a test facility ROBERTINO, a gantry robot for heavy robotics.

Pipes Handling Trials - EU Task RHI.1
(activity carried out in collaboration with ENEA-Fusion Sector)

The maintenance operations on the internal components of the Fusion Reactors, such as blanket segments and divertor cassettes, are carried out by substitution of the damaged components and require cutting and rewelding of the coolant supply lines. Cutting and welding of pipes, performed remotely by using bore tooling, are important aspects of the maintenance operations of any future Fusion Reactor design. The execution of this Task is based on a supporting activity of Computer Aided Design and Simulation, and has required preparatory works on the testing equipment, including the up-grading of the ROBERTINO facility, with the availability of a new control system.

Computer Aided Design and Simulation

The auxiliary equipment and the interfaces with the experimental facility ROBERTINO have been designed by using the CATIA CAD system, with reference to the bore tools for pipes cutting and welding realised by an European Company.
Starting from the CATIA CAD models, the simulation of the process has been performed for the two typical configurations considered, with vertical and horizontal cooling lines feeding respectively the blanket segments and the divertor cassettes, by using TELEGRIP, the commercial package of 3D Kinematics Simulator, selected as reference system for the Remote Handling studies in Fusion.

Up-grading of the ROBERTINO facility

The mechanical up-grading of the experimental facility was started in November '94 in order to perform the present task on pipe handling trials and future tasks on the maintenance of blanket modules according to the new ITER design. The work was completed in mid '95 with substantial improvements to the dynamic behaviour of the facility during the trajectories.

ROBERTINO Control System

The new ROBERTINO Control System, specially conceived for the experimental requirements of the facility, has been developed as a Safety Critical Computer System, in conformity with the most updated standards /1/2/, to ensure high reliability and safety conditions/3/4/.
The new control system, based on VXI bus with operative system VX Works, is configurable and modular in order to allow the integration of other manipulators to assist the ROBERTINO facility. Further developments are in progress to refine the

system and to allow the link with the Kinematics Simulator TELEGRIP, used as Synthetic Viewing Master System for the application of the Remote Handling Workstation on the ROBERTINO Facility.

Experimental Validation activities

Preparatory work on the ROBERTINO facility and on auxiliary equipment have been carried out in view of the test campaigns on pipes handling, which will be undertaken at the beginning of '96. These preparatory works have included the qualification and re-commissioning of the experimental facility after its up-grading, in order to verify its behaviour during the movements and the precision of positioning.

Plant Availability and Maintenance - Quantitative impact of scheduled and expected unscheduled maintenance - SEAL Task 9 - sub-Task 9.1
(Long-term Programme for Safety and Environmental Assessment of Fusion Power)

This study has been undertaken on the basis of the reference commercial reactor configuration, defined in the '94 final report on the Safety and Environmental Assessment of Fusion Power, with the aim of evaluating the resulting plant availability, by taking into account the maintenance impact and the related safety requirements, and identifying possible alternative procedures which could improve availability. The first preliminary evaluations have been performed, by taking into account studies carried out in this field by European Industries.

References:

/1/ E. Ruiz Morales, *A Software Development Approach for Robotic Control System*, Proc. of SAFECOMP 95, Belgirate (I), October 1995.

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Vessel, In-Vessel Components

The objective of the ISEI activity in this area can be briefly summarised as the study of the electromagnetic (EM) forces and related effects on blankets and other structures surrounding the fusion plasma torus. This research field remains one of the major items of fusion by magnetic confinement, where JRC/ISEI has actively contributed. In particular, the execution and co-ordination of the Tasks T15, T209, D201-2-4 & D204-7 are related to the Structural Integrity Assessment of Vessel and In-Vessel Components during Plasma Disruption Off-Normal Events. The modern computer simulation tools CATIA and PATRAN for the modelling activity, CARIDDI and ABAQUS for the electromagnetic and mechanical (MECH) analyses have been extensively used in this context.

Vacuum vessel models for dynamic mechanical simulation - ITER Task T15

The European co-ordination and execution of ITER Task T15 has been completed during the 2nd quarter of 1995. The activity was devoted to the dynamic mechanical (MECH) simulation testing of vacuum vessel (VV) models. Different 3D finite element models of ITER components have been created for successive EM & MECH computer simulations /1/. A complementary paper on the internal blanket reinforcement has been published /2/.

Magneto-mechanical dynamic analysis of in-vessel components - ITER Task D204-7

In complement, efforts have been spent in the execution of Emergency Subtasks 7/1 & 7/4 of ITER Task EC-D204. They were related to the magneto-mechanical dynamic analysis of the :
— Back Plate Component of the Shielding Blanket /3/;
— Housing of the ITER Divertor Cryo-Pumps /4/.
A special procedure for 3D graphic post-processing has been optimised and applied to several analysis cases /5/.

Electromagnetic effects generated by plasma-first wall interaction - ITER Task D201-2-4

The objective of this activity has been the study of the electromagnetic (EM) effects generated by plasma-first wall interaction in the Tokamak during EM

transient conditions. In particular, plasma vertical displacement events have been analysed using a 3D electromagnetic code (CARIDDI) /6/7/8/. A numerical model to simulate the plasma-first wall contact during such vertical instabilities is under development. One major goal is the evaluation of the distribution of the halo currents conductively transferred to the first wall and the computation of the contact forces acting on it, in addition to those due to the induced eddy currents, and eventually transferred to the vacuum vessel and supports.

Dynamic behaviour of blanket support system ITER Task T209

In the meantime, the activities description and work plan proposed for the next ITER Task T209 were defined and discussed during several meetings held in Garching, Bologna, Ispra and Seriate during 1995. The objective of this task is to analyse the dynamic behaviour of the blanket support system under off-normal plasma operation conditions, such as disruptions. A strong collaboration between JRC and ENEA has been developed. The study of the behaviour of the blanket support system will be focused on a 3D model development and validation. JRC/ISEI has been proposed for the European co-ordination of the task/9/.

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Safety and Environment

Thermal transients analyses for the design guidelines and assessment were carried out including all possible in-vessel energy sources, i.e. decay heat, chemical energy, plasma heat flux. The development of an integrated set of software tools to support the various stages of the probabilistic safety assessment of ITER has been undertaken.

In-vessel Loss-of-Coolant and Loss-of-Vacuum Accident analyses - Subtask S81TT01/3

The objectives of this activity included: (a) the detailed 2-D modelling of one First Wall/shield/VV sector and calculation of the decay heat-driven transients; and, (b) the use of a benchmarked simplified model to develop 180 degree description of the ITER torus.

The development of these tools will facilitate the transient studies of in-vessel accidents involving failure of e.g. 1/4 of the coolant.

Thus, following the latest modification in the in-vessel design of the reactor, a detailed model of a 7.5 degrees sector of its first wall/shield/vacuum vessel following the ITER-Interim Design Report this time has been developed, using the new version of ABAQUS, another commercial finite elements code already in use in the ITER community. All energy sources have been included in the model (i.e. decay heat, chemical reactions, plasma heat flux). First results of the transient envelope calculations have already been obtained and are currently under analysis and documentation.

The long-term output of this work will be the

development and implementation of a comprehensive methodology and computational tool for the integrated evaluation of all in-vessel loss-of-coolant and loss-of-vacuum or loss-of-flow accident scenarios of relevance to ITER.

In-vessel 2D/3D transient thermal analyses detailed modeling - Subtask SEA 3-5

The objective of this task was the study of the impact of the interaction between plasma-facing material and steam or air in the case of an in-vessel loss of coolant or loss of vacuum accident on the safety of International Thermonuclear Experimental Reactor (ITER) /1/.

Two finite element models of the ITER first wall have been developed in order to study the impact of the reaction between Be and steam on reactor safety. The first one followed the TAC-4 design and the second the ITER-Interim Design Report. The plasma heat flux was considered to fall upon a "hot band" 10-20 cm large all around the plasma-facing surface of the outboard first wall. Various simulations were performed varying (a) the initial temperature profile across the depth of the hot band, and (b) the plasma power flux and the duration of the heat pulse.

From the simulations varying the initial temperature profile, the following conclusions /2/3/ emerged:
- the released energy due to the Be-steam reaction is small, compared with the other energy inventories, it is not enough to sustain the oxidation;
- in the first few minutes from the plasma shutdown, the transient process depends mainly on the "bulk" first wall temperature while in the long term it depends mainly on the decay heat;
- the transient is quite insensitive to the reaction rate. If a substantial temperature gradient is initially present across the Be layer, the temperature at the reaction front relaxes to about 550 C in less than 10 s, producing less than 0.5 gr. of H_2. If the whole Be layer is close to its melting temperature, the corresponding values are 200 s and 177 gr. of H_2 respectively. From the simulations varying the plasma power flux on the first wall, the following conclusions /4/ can be drawn:
- the "hot band" surface reaches rapidly the Be fusion temperature. A substantial quantity of the material melts, while for sufficiently high heat fluxes, a small amount of Be vaporises;
- upon the end of the plasma pulse the "hot band"

temperature relaxes rapidly to an "equilibrium" bulk temperature defined by the decay heat removal transient. Runaway of the Be-steam reaction is highly unlikely, 200 gr./m^2 can be considered as the upper limit for H_2 releasable by the reacting surface;
- the quantity of the vaporised Be after the 60 MW/m^2 pulse is very small, producing some 2-3 gr./m^2 of H_2 even after complete Be vapour oxidation;
- if all the melted Be enters the vacuum vessel in droplet form, the maximum "hot band" temperature will be limited to 1556 K (fusion point) with beneficial consequences to the "hot band" surface H_2 production. On the other hand, accurate prediction of the dispersion, redeposition and reaction of the Be droplets with steam is very difficult. Preliminary calculations have shown that if the Be droplets continue to react with steam to full oxidation of the material, significant and hazardous amounts of H_2 can be generated.

Future work in this very important area for the safety of ITER should include the detailed investigation of the Be or other coating material behaviour and chemical reactivity under the above described conditions.

Envelope post-accidental thermal transients Subtask SEA 4-4

The goal of this work has been the analysis of the divertor post-accident temperature transients under worst-case envelope conditions. A flexible, detailed yet fast finite element model of the divertor area has been developed on ABAQUS following the ITER-IDR design of the divertor plates. The model allows flexibility in defining different loss of cooling scenarios (complete or partial) as the cooling in only some of the cooling channels can be arbitrarily shut off.

It includes both decay and chemical reaction heat (assuming Be coating) terms, while both the magnitude of the deposited heat flux of the plasma and the time duration of the heat pulse can be varied. Moreover, the short-term temperature transient for a heat load from the plasma of 20 MW/m^2 power flux and 10 s duration has also been computed.

To date, the steady-state temperature profile of the divertor plates under normal operating conditions have been calculated. Over the next few months,

simulations of different accident scenarios (different plasma heat fluxes, pulse duration and cooling availability) will be done and their results will be fully documented. The long-term developments in this area include the in-depth analyses of the thermal transient behaviour of the divertor area including all possible energy sources, a large array of cooling scenarios and alternative materials choice and zoning configurations.

Plant safety assessment tools and data
Subtask SEA 4.1

The objective of this work is to develop an integrated set of software tools to support the various stages of the probabilistic safety assessment of ITER. This new software environment, called STARS-ISAD will be based on an existing environment, the STARS system, that will be customised and extended over to cover the specific needs of ITER.

The STARS software environment was migrated to the ITER selected target platform. This alpha-version of the software was reviewed by ITER and other partners of the task. ISEI developed a beta-version of the software taking into account comments from the review of the alpha version. It was acknowledged that the STARS environment will provide the overall software environment of ISAD (ITER Sequence Analysis Database): ISAD will consist of a dedicated STARS system configured to meet the specific needs of ITER.

Manufacturing and testing of sacrificial
components ITER Task T6

High heat flux components like the divertor plates may include sacrificial elements attached to a permanent heat sink, typically beryllium plates attached on copper acting as a heat sink. Use of Reocast alloys at the interface (instead of brazing) may be a viable solution that assures good thermal contact without transmitting the associated thermal stress. The technical solution described above needs to be characterised and experiments are in course at ENEA (I) and CEA (FR).

ISEI provides numerical modelling support and help to the characterisation of these materials. First thermal models of the ENEA mock-ups have already run and results have provided valuable input on the determination of the required Be width to ensure the satisfactory (with regard to safety) thermal performance of the alloy material under the considered thermal fluxes.

The work anticipated for the first part of 1996 includes the completion of the documentation of the final analysis results and the continuation of providing support and validate these results against the experimental programmes of CEA and ENEA. The long-term interest outcome of this concerted effort is the development of alternative materials for the use in sacrificial elements of the Vacuum Vessel structure to ensure reliable safety performance of these materials.

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SUPPORT TO THE SECRETARIAT GENERAL

In the framework of S/T support to the EC's antifraud services, the JRC-Ispra continued its effort in applied research, development work and consulting.

The following projects were completed in 1995:
— The business process analysis project UIMS. This project identified customers of the antifraud services of UCLAF, process requirements and macro-functionalities for UCLAF's information systems (T.Schael, RSO, 1995) /1/. Relevant information resources for antifraud work were catalogued. The project included also a feasibility study which outlined possible further developments (PLANET, 1995) /2/.
— An exploratory data analysis on cases in the IRENE (national fraud notifications) database until mid-October 1994 was completed and a final report /3/. was prepared and submitted to UCLAF. The report describes the volume of IRENE data via appropriate summary statistics, summarises what appeared to be data curiosities and outlines further work to be done.
— A preliminary study (project FREDI) on giving to member state authorities selective access and remote data entry facilities for the EC's national case notification database (IRENE) using new computer communication technologies (EDI) /4/.
The JRC contributed to the specification of a proposal for a multi-project work envelope on behalf of UCLAF, in the framework of competitive support work for 1995 and 1996.

The JRC did ad-hoc consulting, gave guidance and had technical responsibility over projects under the competitive support heading (IRENE95).
In December 1995, the S.G./UCLAF and the JRC-Ispra signed an inter-DG collaboration agreement for the period 1995-1998, defining the activities to be developed as institutional S/T support to UCLAF. Institutional activities have a long-term focus and are aimed at creating infrastructure or answering basic questions and problems. The work programme includes information systems development, data analysis and risk analysis, computer communication systems, and education and training on the above.

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SUPPORT TO INTERNATIONAL CO-OPERATION (DG I) - SUPPORT (IAEA)

3D Reconstruction

This activity aims at the development of techniques capable of contributing to a solution to the Design Information Verification problem. For complex nuclear plants, such as large reprocessing facilities, there is the need to check a large number of vessels and associated pipework. These inspections are done for ensuring that the plant "as built" respects the plant design /1/2/. The methodology that is used is to acquire 3D data locally by means of a laser range scanner, and later compare the consistency of this data taking as a reference the approved plant design (CAD model). To make an effective verification, there is the need to identify the discrepancies between the real plant and the model, i.e., to detect:

— the elements that have not (yet) been built,
— the elements that were built disregarding the plans.

Figure 2.23. shows some views of a 3D reconstructed model of a laboratory scene.

Range Data Acquisition

Considering that the quality of the 3D reconstruction depends strongly on the characteristics of the laser range scanner, special attention must be given to the selection of the parameters that characterise the acquisition procedure. Moreover, studies were made to prepare the specifications for a 3D data acquisition system adapted to the requirements of this application. The following aspects should be considered:

— the area to be covered in a scan;
— image field of view: scanning angle in both the horizontal and vertical directions;
— image resolution: the angular distance between two consecutive samples;
— measurement time, the accuracy, statistical fluctuation and resolution of the distance measurements are dependent on the measurement time;
— the footprint dimension of the laser beam used;
— the scanning speed.

Hybrid Algorithm for Surface Segmentation

An hybrid algorithm combining edge and region detection is used for range image segmentation /3/. The algorithm outputs both a segmentation map and an edge map. In addition, the edge map conveys both "jump" and "crease" discontinuity information, and the segmentation map provides information on adjoining surfaces that resulted in the formation of edges and defines boundary conditions. This information is most useful for occlusion detection.
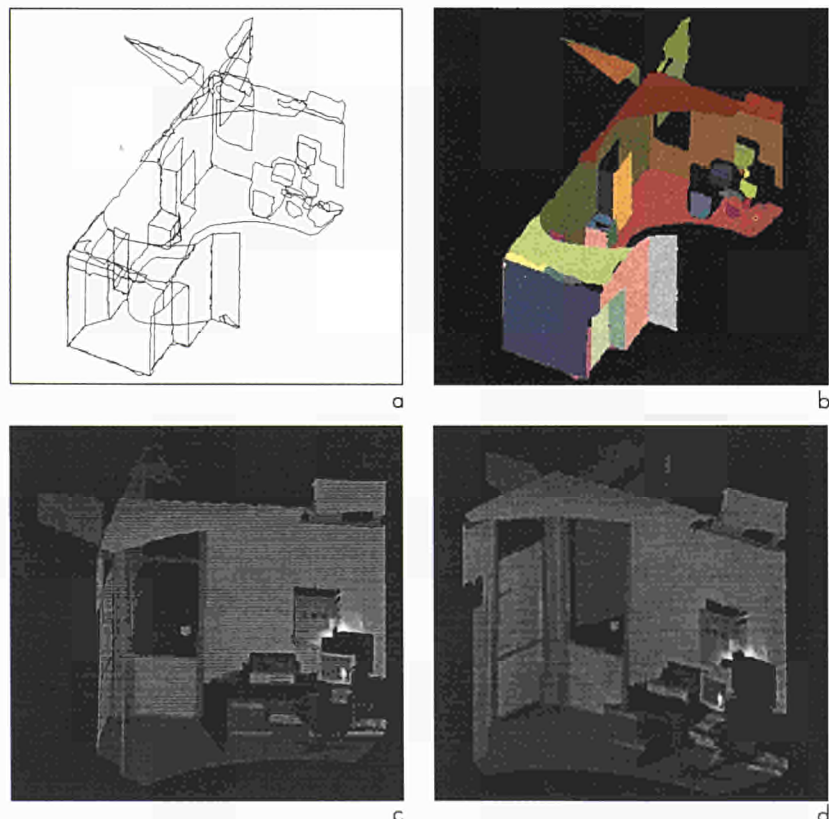

a

b

c

d

Fig. 2.23 Views from a 3D reconstruction of a laboratory scene. a) boundary description; b) surface description; c) and d) textured models from infrared reflectance image.

Registration

Registration is an important step in this work. Indeed, it is virtually impossible to make the 3D reconstruction of a given environment with just a single range image. As long as there are occlusions, there is the need to re-acquire range data from the scene at a different location. The registration approach followed is directly supported on raw range data /4/. It finds in an iterative way the 3D transformation minimising the distance measured between two geometric shapes being registered. The iterative algorithm assumes that an initial estimate of the 3-D rigid transformation between two partially overlapping range images is available. It can be obtained by a high level registration process or provided by the data acquisition process.

Integration of Multiple Views

After the registration of neighbouring views, a surface description using the hybrid algorithm is constructed for each view /3/5/. The surface descriptions of the different views are then transformed to a common co-ordinate frame. For constructing the model resulting from the combination of the multiple views, an average of the samples that are in the overlapping surfaces of the views is performed. The surface patches that overlap are detected and the surface parameters that fit to the fused data are adjusted. The merged surface is then expanded to the edge points, that were previously merged, and the boundary is reconstructed.

3D Object Visualisation

A commercial workstation was configured with special graphics hardware to speed up the processing and visualisation of the generated 3D models. Two 3D visualisation tools were tested, one developed in-house, and a commercial one based on VRML (Virtual Reality Modelling Language), an emerging standard in what concerns the representation of 3D objects. VRML is becoming the standard of communication for 3D images within Internet's World Wide Web.

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Volume Measurements

Two capacitance probes have been installed in the MiniTame Laboratory for evaluating their performance for level measurements in tanks. The software has been upgraded. The TANCS software developed by Batelle was tested in MiniTame.

An inspector software, PORTAME, was also developed. This new tool allows the inspector to check the calibration carried out by the operator or it could be used for long time monitoring of levels and density in large tanks. Three types of Level Measurements Units have been designed. An unique software for the data acquisition and the set-up of the instrumentation is also under development. A new continuous recalibration technique should be implemented in the MiniTame laboratory. A very long time inspector monitoring unit will be developed in the early 1996.

Performance Assessment of Inspector Instruments and Devices under well Defined Environmental Conditions in the LaSCo Laboratory

LaSCo laboratory was asked to give support to IAEA for the modification of the present IAEA testing procedure STR 284 for qualifying C/S equipment and devices.
A first draft of this new version of testing procedure was prepared based on MIL and IEC standards and sent to Vienna in June 1995.

After discussion with IAEA's staff in December 1995, it was agreed that a meeting will be held with various experts in order to define a draft for a new version of a test procedure that will be based on IEC thermal, humidity, mechanical and electromagnetic standards in order to qualify the equipment used by IAEA under international standards and also to guarantee their good operation under the various real conditions that could occur during the life time of these equipment.

Following the various needs concerning the qualification of IAEA equipment, various test work schedules were defined this year on the following equipment:
- a digital pressure module "Solartron". This test procedure includes thermal, humidity, mechanical and electromagnetic characterisations of the module under IEC standards,(Document TPRO/95/112-1 of December 1995);
- the EMOSS digital surveillance system for which first comments were sent to IAEA in order to define the various test levels that need to be apply on the system;
- an Uninterruptable Power Supply (UPS) for which the test work schedule is under discussion.

These various equipment will be tested in 1996 in TEMPEST laboratory (LaSCo testing facilities) after agreement of the test work schedules by IAEA.

Delivery of Sealing-Bolts Ordered by IAEA

The support to the IAEA has continued and consisted in the delivery of Sealing-Bolts ordered by the International Atomic Energy Agency in Vienna. These Sealing-Bolts are destined to the same use as those provided to EURATOM, since they are installed by joint inspection teams. The bolts were delivered in time.

Portable Reading Equipment of interest to IAEA

The recent development of a compact "Reading Instrument" developed by JRC-Ispra for ultrasonic seals (Hardware and Software) has been fully documented to the IAEA. The results have been identified by the IAEA as completing the original target for JRC-Ispra to provide a "commercially based" reading equipment prototype which could be used by IAEA inspectors while reading JRC like ultrasonic seals.

SUPPORT TO COMMUNITY INDUSTRIAL POLICY DG III

Safety and Reliability of Systems

During 1995, the Institutional Support activities for DG III/F (Information Technologies) were focused in the subject area of the Safety and Reliability of Systems (encompassing safety-critical systems (SCCS), robots and safety-relevant systems). The work has centred around the agreed mechanisms for supporting the actuation of DG III/F's programme by:
— fostering awareness on the availability and usability of leading-edge technologies in SCCS,
— provide premises, facilities and skills to support projects to demonstrate through benchmarking and collaborative network actions the viability of their methods and technologies;
— contributing to the dissemination of DG III's programme's results by pooling together industrialists and researchers around focused events such as test cases, benchmarks, viability projects;
— organising and managing Industrial Clubs/ Interest Groups on specific technological solutions.

The work in 1995, has focused around activities which disseminated information, fostered awareness, provided input to the R&D programme from industrial and research groups, provided foundation work on a measurement framework for incident analysis. In detail, the work has included:
— organising (together with the European Workshop on Industrial Computer Systems - Technical Committee 7 - EWICS TC7) the Safecomp'95 Conference at Belgirate (Italy) in October 1995. This successful event attracted over one hundred participants from Europe, North America, and the Far East. It provided a platform for interchange of research, industrial and academic experience in the area of systems safety and reliability. Both R&D and ESSI projects were able to present and discuss their achievements and findings. The full proceedings of the conference were published in book form /1/.
— organising an Industrial Workshop on Requirements Engineering at Ispra (Italy). The workshop identified and prioritised industrial and technological needs for Requirements Engineering. It provided suggestions from industrial participants as how to align these needs to current EC research mechanisms. It also provided an industrial view on the adequacy of existing R&D implementation mechanisms. A detailed report of the workshop has been produced /8/9/10/11/.
— development activity on dependability measurement by data collection has been ongoing throughout 1995. Its aim is to collect operational incident data related to systems containing software components and to define a model of incidents which allows causal analysis plus a framework which allows measurement of product and process. This work will help to underpin research activities which aim to evaluate software engineering processes. During 1995, a report has been published and a workshop has been held at Ispra /6/7/.
— Setting-up of a World Wide Web containing a Directory of Safety-Critical Computer Systems (SCCS) activities. The Web pages have been set-up and are available on a limited basis. They contain information and pointers-to -information about R&D activities in SCCS. They give information about events, standardisation, links to other Web pages on related subjects. The Web will be made generally available early in 1996.
— information on standardisation in the area of SCCS. Within the Web pages of the Directory of SCCS, a hypertext of information on related standardisation activities has been set-up. This contains information on sectorial, national and international standards on safety, SCCS and related activities in software engineering, reliability and security. The first set of information and connections has been set-up in 1995. This work will be ongoing in 1996.
— methodology for safety assessment during the requirements phase of software-based systems is under development /2/3/4/5/12/13/14/.

During 1995, planning activities have been performed, together with DG III/F, in order to define a wider area of Institutional Support activities in Information Technologies for the period of 1996-1998. This will focus on the support activities in the areas of: High Performance Computing and Networking, Geographical Information Systems, Generic Systems Interfaces, Intelligent Decision Support Systems, Computer Integrated Manufacturing.

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Geographical Information Systems

In 1995 the Institute was approached by DG III F4 (Software Systems and Software Best Practice) to provide support to the co-ordination of their activities in Geographic Information Systems. This is seen as an area where European Industry needs to strengthen its developments and to achieve a greater level of harmonisation and co-ordination of its activities in order to become more competitive in a market which has been, up to now, dominated by a small number of American companies.

There are currently a number of European groups and networks focusing on Geographical Information, in particular the European Umbrella Organisation for Geographical Information (EUROGI) and there is a proposal to set up a European Geographic Information Infrastructure (EGII) analogous to the Spatial Data Infrastructure in the US. It is therefore necessary to develop appropriate strategies and concentration mechanisms to ensure the most effective Commission support in this area.

Owing to its growing base of resources and competencies in GIS, and its experience in the application of GIS to a range of projects ISEI is now well placed to co-ordinate this support. The work will be carried out in collaboration with IRSA.

Discussions were held with DG III and it was established that the JRC would give support to co-ordination of GIS projects, organise and conduct regular workshops, and perform information dissemination activities such as preparation of brochures, posters and world wide web pages. Overviews of European activities in this area, including the various initiatives within the Commission, will be prepared with a view to identifying synergies and avoiding duplication.

At the end of 1995 a detailed programme for 1996 activities was defined, and is summarised below:

Support to DG III re. GIS - Planned Activities for 1996

— Organise 2nd EC GIS Workshop

— Follow and Contribute to Activities of GI2000

— Dissemination of Information
  • Web Server of GIS Projects
  • Produce project Summaries Book
  • Produce GIS Poster/Depliant

— Establish Plan for Concertation Mechanisms

— Produce long term strategy document

SUPPORT TO THE COMMUNITY AGRICULTURAL POLICY (DG VI)

Electronic Animal Identification

This research project was assigned to ISEI by the Directorate General for Agriculture (DG VI) FEOGA Unit VI-G-4 in order to prevent fraud and to respond to the specific problems presented by the registration, identification and management of individual livestock.

This new project, involving 10 partners, includes the technical assistance of ISEI on the theme "Coupling active and passive telemetric data collection for monitoring, control and management of animal production at farm and sectorial level". This project studies the feasibility of the electronic identification on farm animals as well as the monitoring of various physical parameters. The results will be used for the definition for the electronic identification of a large number of animals covering various states in Europe that will be electronically identified in order to validate this technology so that the Commission will be able to apply its directive 92/102 "Identification et Enregistrement des animaux".

ISEI provides a technical assistance on different points:
— definition of the technical characteristics of the electronic identifier that needs to be used, as well as of all the reading and data processing equipment (radio frequency modules, antennas, portable readers, computers etc...);
— definition of testing procedures for all these equipment in terms of thermal, humidity and electromagnetic tests as well as in terms of performance characterisation in order to give some guidelines for the choice of the appropriate pieces of equipment. These testing procedures are based on IEC standards and on in field observations and measurements in order to

guarantee the conformity of the various equipment used versus various international standards and also to guarantee their good operation during their real application in field;
— development of special control benches for endurance tests of equipment;
— testing of the above equipment as well as of various software used to drive them and to process the data (Identification number and data corresponding to the animals);
— follow up of the in field application of the electronic identification.

During 1995 tests were conducted on:
— 10 RI-TRP-WB2B-03 read/write transponders /1/;
— a study of the electric field generated by the various farm equipment used in the University Autonoma of Barcelona experimental farm /2/;
— the performance comparison on 5 types of passive indentifiers (injectables ruminal boluses and ear tags) /3/ (Figure 2.22);
— thermal and mechanical behaviour of these 5 types of passive transponders /4/;
— thermal and mechanical behaviour of an auto-tuning radio frequency module used for dynamic animal reading (Figure 2.23).
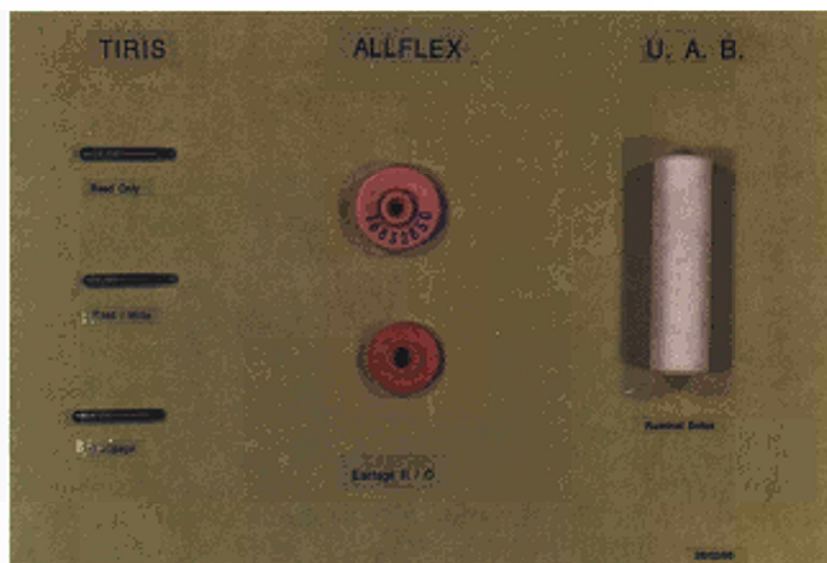

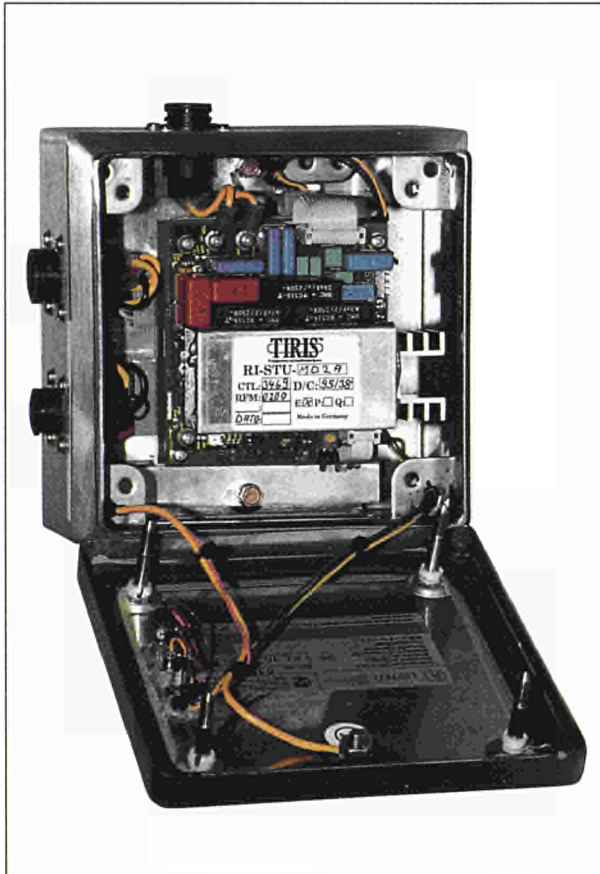Fig. 2.24 The five types of passive transponders tested

Fig. 2.25 The auto-tuning radio frequency module used for dynamic readings

These test were used for the verification of the ability of the equipment to fulfil their application and also to prepare a large scale project at a European scale.

The test programme foreseen for 1996 in the framework of the electronic animal identification is the following:
- electromagnetic immunity and emission tests on the dynamic reading systems (RF module and antenna);
- performance and environmental tests on various sized electronic transponders;
- performance and environmental tests on various portable readers;
- study of the electromagnetic conformity of various reading systems with the rules of different European countries;
- endurance tests of readers and transponders;
- environmental tests on various antennas used for dynamic and stationary reading;
- electromagnetic and environmental tests on DC power supplies used for the dynamic reading systems.

ISEI will continue its technical assistance for the preparation of a new large scale project and for the in-field follow up.

References:

/1/ C.Korn, S.Venezia, "Thermal and Mechanical tests on the RI-TRP-WB2B-03 read/write transponder used for animal tagging", Technical Note I.95.29, J.R.C. Ispra, March 1995

/2/ C.Korn, G.Azzalin, "Study of the Electric Field Generated in the UAB Experimental Farm in Barcelona", Technical Note I.95.84, J.R.C. Ispra, June 1995

/3/ O.Ribo, G.Azzalin, C.Korn, "Performance Comparison Test on Passive Transponders Used for Animal Tagging", Technical Note I.95.160, J.R.C. Ispra, November 1995

/4/ O.Ribo, G.Azzalin, C.Korn, "Thermal and Mechanical Tests on Passive Transponders Used for Animal Tagging", Technical Note I.95.161, J.R.C. Ispra, November 1995

Volume Measurements for Anti Fraud

In the framework of the anti fraud policy of the Commission, a need has been identified to verify the volume of vegetal oil storage tanks.

The level measurement technique based on high precision manometry is used for many years in nuclear industry for the determination of liquid volume in large vessels in bulk handling facilities (for instance in input and output tanks in reprocessing plants). One of the advantages of this technique is that it is possible to measure in few seconds the level and in the same time the density of a solution. In order to study the applicability of this pressure measurement technique for the determination of the level and density of vegetal oil in tanks, some preliminary tests were conducted on a small tank in MiniTAME laboratory (LaSCo) with olive oil. These first positive results were presented in an internal technical note /1/ to DG VI-G4 in November 1995.

Some contacts have been taken in December with the A.I.M.A. and Agecontrol of Rome (Italy) to

discuss the exact needs with this control agency. A technical visit is foreseen to an oil storage plant, near Bari, in order to collect the necessary input for the development and the installation of a specially designed prototype composed of the necessary hardware (tubes, valves, rotameters, manometers,...) and also to study the user's requirements to define a dedicated software for the data collection and processing.

Reference:

/1/ D. Landat, "Essais préliminaires sur l'utilisation de la manométrie de précision pour le contrôle contre la fraude dans le domaine de l'agriculture", Internal Technical Note No. DL/10/01/MT, J.R.C. Ispra, October 1995

SUPPORT TO THE COMMUNITY ENVIRONMENTAL POLICY (DG XI)

Safety of Nuclear Installations

This activity is aimed to provide scientific and technical support to the Commission DG XI - Division Safety of Nuclear Installations in the area of Nuclear Safety. The implementation of the Council Resolutions of 1975 and 1992 on the technological problems of nuclear safety, determines two major spheres of activity of the Division Safety of Nuclear Installation:
— The harmonisation of the rules and safety criteria, with the support of the two standing advisory groups RSWG (Reactor Safety Working Group) and NRWG (Nuclear Regulators' Working Group).
— Assistance/co-operation with Central and Eastern European Countries (CEECS) and with the ex-USSR.

The activity is foreseen for the period 1995-1998 and is performed according to a collaboration agreement signed at the beginning of 1996 between DG XI and JRC-ISIS, the new Institute resulting form the merging of the two JRC Institutes ISEI and IST. General areas of competence are envisaged for JRC-ISIS to support DG XI, explicit support is also requested for the assistance/co-operation activity with CEECS and the ex-USSR. In 1995 the activity was performed separately by ISEI and IST in a co-ordinated way. Five main collaboration subjects are identified:
— Probabilistic Safety Assessment (level 1, 2, 3) including Human factors;
— Severe accidents (realistic evaluations, accident management, source term);
— Thermal hydraulics (evaluation of existing safety margins with respect to Design Basis Accidents DBA);
— Seismic assessment: updating of the European earthquake catalogue and of its version on a Geographical Information System. Development of catalogue of a new generation.
— Technical support relevant to nuclear PHARE and TACIS programmes.

The activity performed in 1995 is hereafter detailed.

Support to DG XI activity

During 1995 support was given by ISEI and IST to the unit DG XI.C2 in all the above mentioned areas

including technical monitoring of some of the ad hoc groups formed within the framework of the working groups NRWG and RSWG, and the participation, on demand, at some meeting of the ad hoc technical groups. Support for reviewing of the reports resulting from the studies financed by the Commission has been given on specific requests by checking of conformity to the specifications and possibly, specification of the modifications to be made in view of a publication. In addition, advise on the technical content of a number of proposals to call for tenders has been given. The work performed is documented in a number of confidential reports. Advise has also been given for the development of the RSWG and NRWG pluriannual 1996-1999 work programme.

Participation at International Activity (OECD and IAEA)

The support activity to the Nuclear Safety Unit of DG XI included the participation at international meetings of OECD-CSNI (Committee for the Safety on Nuclear Installations) and related Principal Working Groups (PWGs 1, 2, 4, 5), workshops, and lecturing at courses in support to east European Countries. As an example, the participation at IAEA task force on "Development of Safety Principles for the Design of Future NPP" has contributed to the final synthesis document of the task force issued in 1995 as TECDOC.
Finally the following databases are available and can be interrogated by the members of the Commission staff:
— Incident Reporting System (IRS jointly operated by OECD-NEA and IAEA);
— Power Reactor Information System (MicroPRIS by IAEA).

Issuing Catalogues of Historical Earthquake Data

The activity on the European earthquake catalogue has been accomplished according to the mandate. A workshop on the European earthquake catalogue has been organised in October 1995 to define a workplan to fulfil the new DG XI requests adhering to RSWG advise and needs about seismic catalogues.

The Geographical Information System (GIS) containing the European Earthquake Catalogue and details of European nuclear power installations was maintained in operative condition and was used to examine the benefits of a multimedia approach for maintaining links to historical records relating to the earthquake events. One of the main criticisms of the current European catalogue, and indeed of any purely parametric catalogue, is that the links or references to the original historical records have been lost. It has been suggested that for certain kinds of work it is important to have such links, for example to help in resolving possible ambiguities, and to have an estimate of the quality or lineage of the data. Since seismic parameters frequently have to be estimated from historical descriptions, it can be argued that the historical descriptions are more meaningful than the estimated parameters in some cases. With the GIS system used in this work it is very simple to link scanned images or text files describing the original historical records to the parametric database records. In this way when an investigator finds an event or selection of events which are "interesting" for his purposes he can immediately have access to the appropriate

historical records. This possibility has been demonstrated for two cases. A photograph of damage which occurred in the event of Imperia, 1887, was scanned and linked to the appropriate database record. Also some historical text referring to the event of Cartoceto, 1572, was scanned from the same source and linked to the relevant database record (Fig. 2.26), /1/.

Reference:

/1/ Peckham R.J., Heuvelmans E., (1995). Using a Geographic Information System for Management and Analysis of a European Earthquake Catalogue, Proc. XIIIth EUROCARTO Conference. JRC, Ispra, Sept. 1995.

Major Accident Hazards Bureau (MAHB)

Support for the control of major industrial hazards is supplied to DG XI by the Major Accident Hazards Bureau (MAHB) under a memorandum of understanding agreed between DG XI and the JRC in January 1994. The tasks of the MAHB include running the Major Accident Reporting System and the Community Documentation Centre on Industrial Risk.

The Community Documentation Centre on Industrial Risk (CDCIR)

The CDCIR continued to expand its collection of documents in the area of industrial risk, including both published books and magazines and various documents not conventionally published, such as codes of practice, safety regulations, company studies and manuals, leaflets issued to the public, reports of accident investigations, and so forth. The 9th "Bulletin" of the CDCIR, including summaries of all the documents received, was published in both paper and electronic form, and distributed to authorities, industry, and research organisations. The

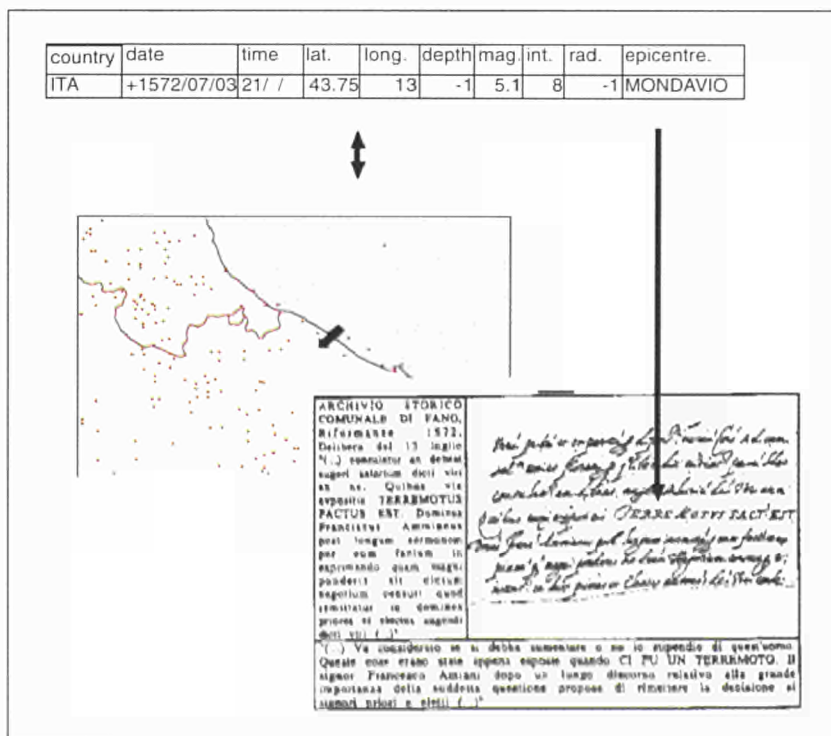| country	date	time	lat.	long.	depth	mag.	int.	rad.	epicentre.
ITA	+1572/07/03	21/ /	43.75	13	-1	5.1	8	-1	MONDAVIO

Fig. 2.26 The multimedia approach for maintaining links to historical records. Links are maintained between the database record (above), the map, and the historical record (below), permitting easy access from one to the other.

Underlying causes of accidents notified in MARS

- MARS up to end 91
- MARS up to end 93

Categories: Mangerial / organisational inadequacy omissions · Design · Procedures not followed · Under investigation · Unknown
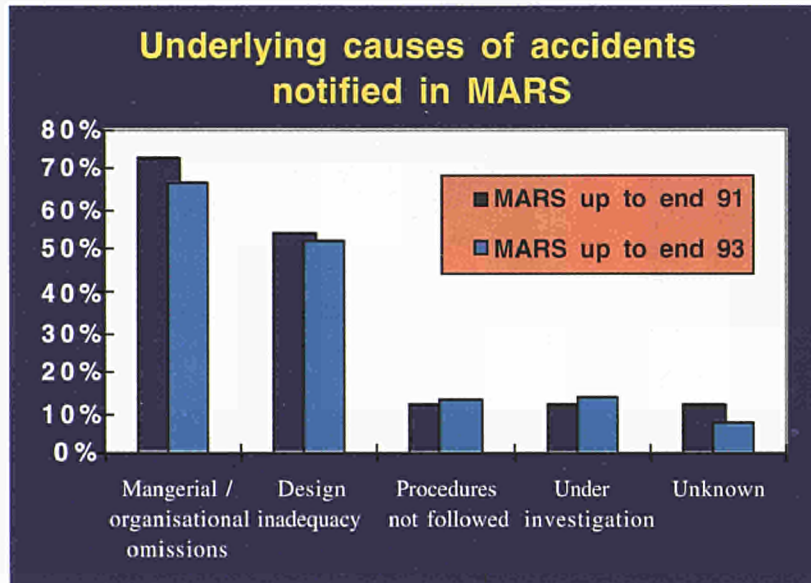
Fig. 2.27 Underlying causes of accidents notified in MARS

CDCIR was also presented at the Antwerp conference on "Loss Prevention in the Process Industries" /1/.

In 1995 the CDCIR series of "Lessons learnt from emergencies after accidents" was completed for all the 12 countries which were Member States of the European Community during the preparation of the series /2,3/ - i.e. not yet including Sweden, Finland, and Austria.

The Major Accident Reporting System

The Major Accident Reporting System continued to operate by recording, analysing, and diffusing information on accidents notified (Figures 2.27, 2.28). As in previous years, the lessons learnt from the accidents notified were reported to and discussed with the Committee of Competent Authorities for the Implementation of the "Seveso" Directive. Furthermore, a report has been prepared on the first 10 years of operation of the system, and is due to be published in 1996. The Italian
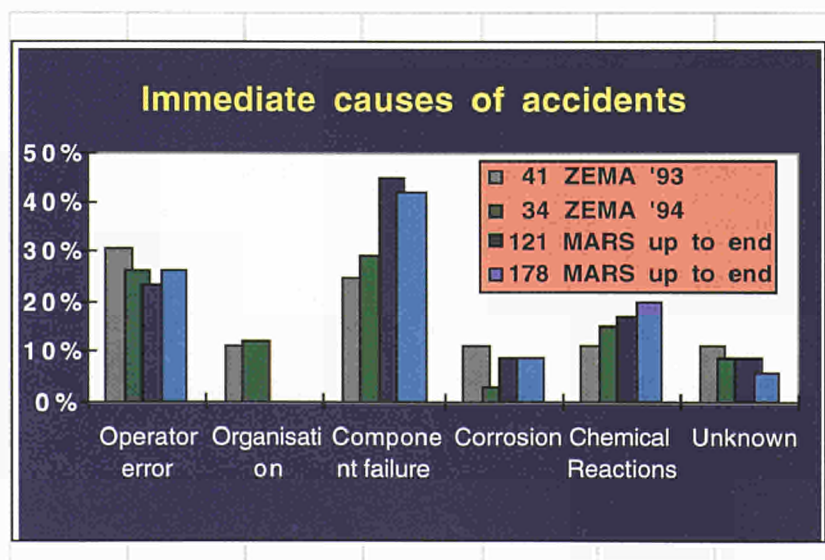
Institute ISPESL (Istituto Superiore per la Prevenzione e la Sicurezza al Lavoro) received a copy of the MARS software to enable the development of a compatible national system for accident reporting.

Technical Working Groups

Various ad hoc technical working groups have been set up by the Commission in collaboration with the National Authorities, and the MAHB co-ordinates several of these, both organising the meetings and preparing draft technical guidance and other material for discussion within the Groups. Participants in these groups come both from National and Local Authorities and also from various international industry bodies such as CEFIC, CONCAWE, E&P Forum, AEGPL, and EPSC. These groups thus represent a significant contribution at European level to a constructive dialogue between Authorities and Industry, mediated by the MAHB and DG XI.

In 1995 significant progress was recorded by two groups, those dealing with Safety Reports and Safety

Immediate causes of accidents

- 41 ZEMA '93
- 34 ZEMA '94
- 121 MARS up to end
- 178 MARS up to end

Categories: Operator error · Organisation · Component failure · Corrosion · Chemical Reactions · Unknown

Fig. 2.28 Immediate causes of accidents

Management Systems /4/; both these groups are expected to complete their work in 1996.

Seminars

The series of technical seminars for Seveso Directive Authorities continued in 1995 with a seminar in October in Toledo on "Accident Scenarios and Emergency Response". This seminar was organised in conjunction with the National Authorities for Civil Protection, and attracted widespread participation from both groups of Authorities, as well as industry and academia - to a total of 120 people.

In addition to a certain number of outside contracts undertaken during the year /5/, further activities of the MAHB were presented at externally-organised seminars and conferences and in learned journals /6/7/8/9/10/11/.

References:

/1/ A. Amendola & C. Carnevali *The Community Documentation Centre on Industrial Risk.* Proceedings of the 8th International Symposium on "Loss Prevention and Safety Promotion in the Process Industries", Antwerp 6-9 June 1995

/2/ J. Ventura, M. Marcedo, N. Sousa, J.A.V. Sanchéz, C.G. Roca, J.N. Melero, S.S. Fortes *Lessons learned from emergencies after accidents in Portugal and Spain involving dangerous chemical substances* EUR 16121 EN (1995)

/3/ F. Behaegel, L. De Grave, M. Haegemann, J.P. Tack *Lessons learned from emergency interventions following chemical accidents in Belgium and in the Grand Duchy of Luxembourg* EUR 16122 EN (1995)

/4/ N. Mitchison & G. Papadakis *Safety Management Systems: International Initiatives.* Proceedings of 3ASI Conference on "I Sistemi di Gestione della Sicurezza", Milan 22-23 June 1995.

/5/ A. Amendola, M. Christou, M. Smeder, S. Besi, F. Amendola, V. Belloni *Criteri per la Pianificazione Territoriale e per l'Emergenza nei Paesi dell'Unione Europea* Rapporto Finale Convenzione ISPESL No. 5571-93-11

/6/ D. Egidi, F. Foraboschi, G. Spadoni, A. Amendola *The ARIPAR Project: Analysis of the Major Accident Risks Connected with Industrial and Transportation Activities in the Ravenna Area.* Reliability Engineering and System Safety, Vol. 49 (1995) pp.75-89.

/7/ A. Amendola & G. Papadakis *Risk Assessment in the Control of Major Accident Hazards in the European Union.* Proceedings of Workshop IV "Environmental Risk Assessment", Seoul, December 1994.

/8/ G. Papadakis *On LPG Boil-off.* Proceedings of the 8th International Symposium on "Loss Prevention and Safety Promotion in the Process Industries", Antwerp 6-9 June 1995.

/9/ G. Bello & M. Smeder, *Study on Industrial Installations presenting Major Hazards for Groundwater.* Proceedings of DVWK Workshop on "Protection of Groundwater against substances used in Technical Installations", Bonn, 2-3 November 1995.

/10/ M. Christou & G. Papadakis *Risk Assessment as an Important Parameter in Safety Management and Decision-Making.* Proceedings of 3ASI Conference on "I Sistemi di Gestione della Sicurezza", Milan 22-23 June 1995.

/11/ A. Amendola *Industrial Accidents - Management of Risk.* Proceedings of HELECO '95 Second international conference on "Environmental Technology for the Mediterranean Region", Athens 9-12 November 1995.

Biosafe

The scientific-technical support to the policy of the Directorate General XI in the area of biotechnology was continued with an emphasis on three major areas: the development of a special electronic system to allow electronic exchange of notifications between Member States and the Commission, the further development of a documentation centre on biotechnology safety and regulation and the direct scientific-technical support to DG XI, especially in the form of the organisation at the Ispra site of a EC-US Workshop.

Progress has been made in the following forms:
— Support in the exchange of information between Member States and the Commission on the issue of deliberate releases into the environment of transgenic plants.
— ISEI has designed and developed a prototype database and presented it at the Committee of Competent Authorities for approval. The project is now in its completion phase and will be operational by mid April 1996.
— The second edition of the bulletin on biotechnology safety and regulation has been issued in February and mailed to about 800 clients (Competent Authorities, their expert committees, representatives from industry and academy). Subsequent requests for further information and documents have been handled. The third bulletin is in preparation and due to be issued in early 1996.
— Scientific support has been provided in the form of the preparation of working documents. Technical support was provided by the organisation of the 4th EC-US Workshop on the release of transgenic plants (held at the Ispra site on 15-16 June). About 50 participants were welcomed from the USA, Canada, Mexico and from the EU.

SUPPORT TO THE COMMUNITY ENERGY POLICY (DG XVII)

Support to the EURATOM Safeguards Directorate (ESD)

Unattended Measurement Station

This project aims at building a station (UMS) for unattended measurements of the radiation and identification of fresh LWR fuel elements. The UMS is being jointly developed by the Institute for Safety Technology (radiation measurements) and ISEI (identification system).

The identification system comprises a personal computer connected to a video camera and an illuminator. Upon request from the radiation measurement computer (master) the identification system i) reads the unique identification number engraved on the fuel element's assembly head, ii) stores the original image for archiving purposes, iii) identifies the character string present in the image by means of image processing and pattern recognition techniques, and iv) transmits the element's identification to the master computer. This procedure aims at an integrated system capable

of associating the element's identification to the radiation measurements. The functional architecture of the identification system is shown in Figure 2.29.

Electronic Clipboard

The ESD requested the development of an "Electronic Clipboard" for inspectors. The procedures to transfer data on seals and the Listing of Inventory Items (LII) from/to a P.C. were implemented. A complete report on these activities have been given to ESD staff. The Electronic Clipboard is ready to be tested in-field by ESD staff.

Volume Measurements

In November 1995, a meeting has been held in Ispra to discuss the performance of Volume Measurement Systems in large tanks for reprocessing tanks. Areas of technical support were identified and the MiniTame staff will provide, next year, the ESD with measurement devices and software. Training courses are planned for the EURATOM inspectors.
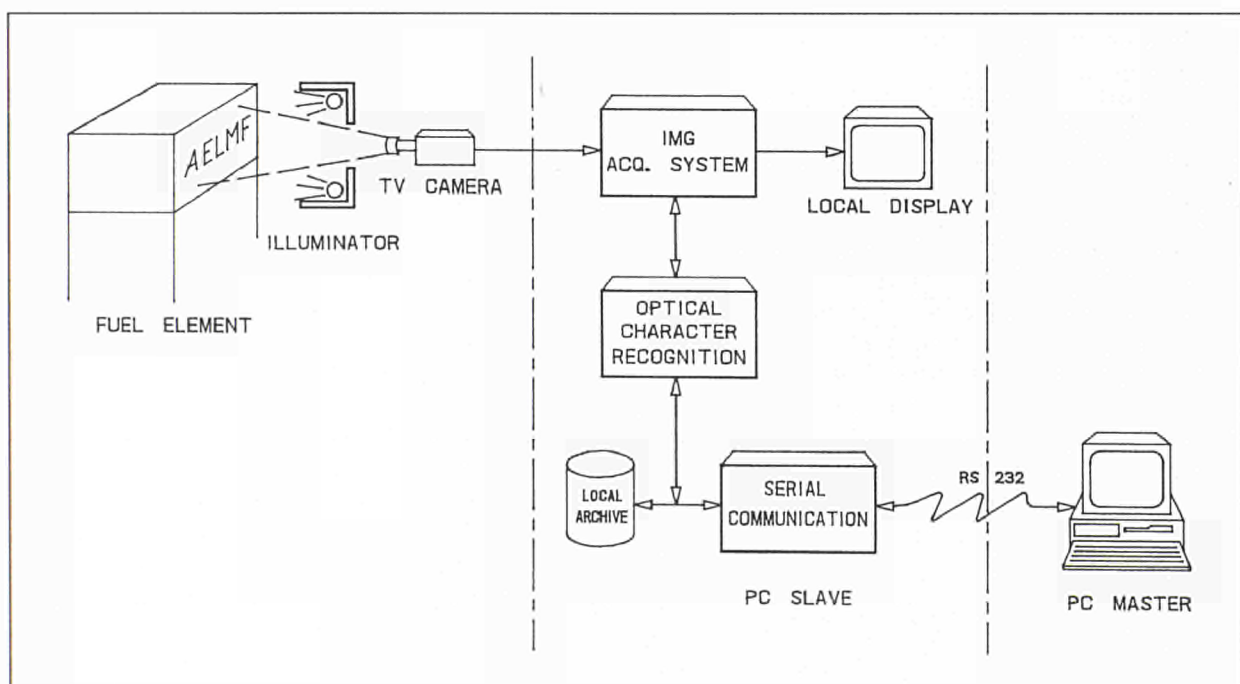
Fig. 2.29 Functional architecture of UMS's identification system

Heat flow sensor surveillance system

JRC Ispra has developed recently in collaboration with the University of Lille (F) a System of Control for Locations and Objects by Parabola (SYCLOP). It is based on Heat Flow sensor. The SYCLOP concentrates the thermal radiation of a monitored environment on a heat flow sensor thanks to a parabolic reflector. The heat flow sensor detects every modification of the thermal equilibrium in the controlled zone. A laptop computer connected to the system enables to adapt for the required sensitivity of the system and serves to store the acquired signals and - if required - to trigger alarms.

ESD identified a first safeguards application: a building at a nuclear facility comprising several storage rooms for nuclear material in different forms. In particular two adjacent rooms with limited access due to high radiation levels are interesting candidates for this kind of surveillance. The system would reduce the need for inspectors to enter the rooms to replace regularly a large number of classic metal cap seals on the individual locker doors.
Design, realisation, installation and testing of a combined set of heat flow antennas, together with the necessary data acquisition equipment and software to assure the adequate surveillance of two adjacent Pu containing storage have started this year. The system will be finally installed during 1996. The task will serve as a pilot project to prove the feasibility of the SYCLOP system for safeguards surveillance.

Environmental and resistance testing of equipment/ system in LaSCo

Due to a new development of electronic seals (AFOS & MINAFOS) conducted ESD, a work schedule was send to the Directorate (TPRO/1112-1) in December 1995 in order to test these new seals. This work schedule specifies the thermal, mechanical and electromagnetic stresses and measurements that will be applied on these new seals in order to qualify them under IEC and EN standards. The tests will start in 1996 after agreement of the test protocol by ESD and delivery of the various seals.

Software for Data Base System CMF-2

This activity has essentially been directed to build software operating at the input and at the output of the new data base system CMF-2, which collects the data reported by the operators of the European Nuclear Fuel Cycle and the verification data of the Inspectorate. The following programs, developed through the Software house Syrea, were completed and delivered to ESD:
- Full automatic transit matching. This programme matches records originating from different sources but referring to the same materials. Program and manual delivered in March 1995.
- Installations data base. This program handles all safeguards relevant information concerning the European nuclear installations. Program and manual delivered in January 1995.
- MADES. This program performs statistical evaluation of the data contained in the CMF-2 master file, according to certain procedures defined by ESD. It is an upgraded version of an existing program; it has been totally rewritten in a new language for operating in the new UNIX environment. The program was delivered in December 1995.

Remote Monitoring Link

The objective of the task is to set up a link between Euratom headquarters in Luxembourg and JRC Ispra for testing the application of remote monitoring in safeguards. This technique will allow the inspectors to monitor from headquarters the surveillance equipment in a remote plant and therefore reduce the on-site inspection effort.

The installed system performs the remote monitoring of ten video channels and ten digital sensors. Surveillance pictures from ten cameras are compressed and stored in a dedicated unit in the plant. Upon request from headquarters or triggered by an alarm signal in the plant, the data are encrypted and sent over public network to another dedicated storage unit in Euratom headquarters. This unit performs also the decompression and demultiplexing of the video channels.

The activity in 95 dealt with the set-up of the systems in Ispra and Luxembourg and with the performance tests of the system. The configuration included two surveillance cameras, motion detector, storage unit, encryptor/decryptor and modems. The encryption key management changes the secret key for each transmission. The compression method is based on JPEG for the first picture of a video sequence and on image difference for the successive images.

The tests have been carried out on public switched telephone network. The first test was to monitor from headquarters in Luxembourg a selected camera in Ispra or a sequence of cameras using different image resolutions. A second test concerned the unattended transmission of data from Ispra to Luxembourg if an alarm was detected by a motion detector. A PC connected in Luxembourg to the storage unit recorded the alarm history in unattended mode.

A demonstration of the whole system was presented to Euratom staff in Luxembourg and the reaction was quite positive. The image quality and the technical features of the system were considered appropriate for the application. The next step will be the connection of the system to ISDN (Integrated Services Digital Network). This connection will reduce considerably the transmission time of video images (by a factor of 8). The equipment of remote monitoring link includes on bottom the storage/compression unit for ten video channels, above the encryptor and the modem, on top the motion detector. Surveillance cameras and a video monitor complete the system configuration. (Fig. 2.30).

Verification System for E-metal Seals

This low cost seal is applied by Euratom to containers of nuclear material and the time interval between installation and verification can amount to several years. The scope of the verification is to detect possible tampering of the seal and its substitution by a similar one. The seal image is constituted by a small metal surface in copper with randomly distributed solder taps and scratches. The verification of the E-metal seal type is performed by comparing the seal image before installation with the seal image after removal during inspection

The verification system comprises a mechanical structure for the positioning of the seal, a TV camera, a special illuminator to reduce reflections on the metal surface, a computer with an image grabbing board and a magneto-optical archive unit of 20 GB capacity. The archive unit is required to store all reference images of the seals before

installation in the plants. The chosen capacity is appropriate for the maximal annual production of 10.000 seals. The work in 1995 concerned the definition of the system configuration, the purchase of equipment and the software development for the transfer of images between computer and archive unit. The other functions of the system will be developed in 96.

Provision of Sealing-Bolts, Equipment and Maintenance as needed by EURATOM Safeguards Directorate in Sellafield (UK)

The ISEI *SILab* Laboratory has maintained its production of MK4-R Sealing-Bolts requested by the EURATOM Safeguards Directorate (DG XVII) for the safeguarding of spent fuel "Multi Element Bottles" at the BNFL site of Sellafield (UK). The monthly production rate of 50 units corresponding to the needs on site has been maintained. So far more than 700 Sealing-Bolts have been provided to DG XVII. In relation to that production, which is expected to continue until 2005, Ispra has dedicated a large effort to the rationalisation and quality control of the Sealing-Bolts production.

Fig. 2.30 Remote monitoring equipment

ISEI has also maintained his tight collaboration with inspectors on site, being present beside the EURATOM/IAEA joint inspection teams each time it was necessary.

In particular the results obtained in R&D on new software could be implemented and demonstrated in Sellafield, the main benefits being the improvement of the measuring procedure on site as well as a reduction of the time spent for each MEB verification in the THORP pond /1/. Also JRC-Ispra has undertaken a maintenance policy based on reciprocal information in order to maintain spare parts at the disposal of Sellafield inspection staff (Figure 2.31).
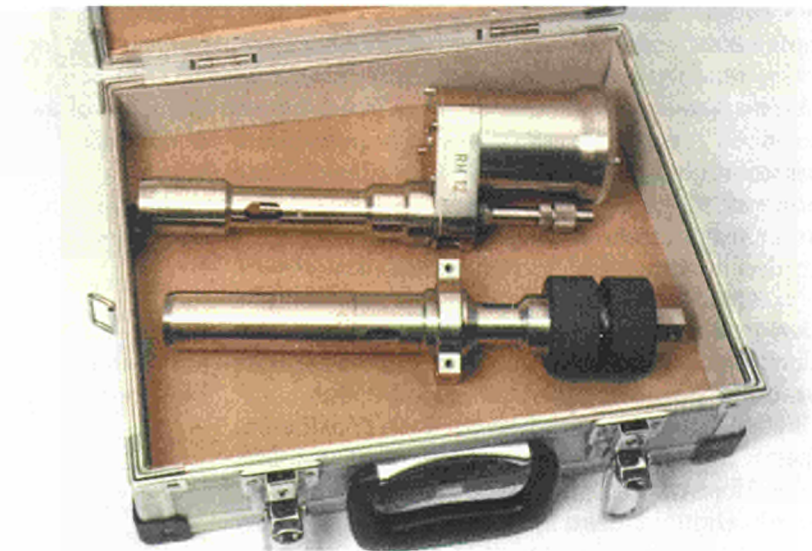
Fig. 2.31 Spare parts (Reading Head & Handling implement) manufactured by JRC-Ispra ready for shipment to Sellafield.

Reference:

/1/ C.D. Hatt, A.F. Reynolds,(BNFL); B. d'Agraives, J. Toornvliet, (SILab JRC-Ispra); A. Jeffrey, P. Detourbet, (DGXVII); B. Wilt (IAEA), Operational Experience of Ultrasonic Sealing Bolts for Safeguards Containment of Multi-Element Bottles in British Nuclear Fuel's Thorp Spent Storage Ponds, ANS 5th International Conference on Facility Operations - Safeguards Interface, Jackson Hole, Sept. 1995

Provision of Central Data Base to the Safeguards Directorate HQ in Luxembourg

The management of an increasing number of sealing-bolts installed on site is such that the Directorate in Luxembourg is needing a new and flexible management tool which could be used in Sellafield and at headquarters. The development of such a Data Base (Seal_DB) has taken about two years and has been completed by mid-1995. During the rest of the year several versions have been tested on site in association with the new data transfer/inspector procedure called DAP4.0, to be used for the data preparation, transfer and processing before and after the verification campaigns. The work has been completed and a Central Data Base is now available for Luxembourg HQ.

New approach for Fuel Storage Baskets

Another support to the Safeguards Directorate consisted in studying on their request a new dedicated sealing system for underwater use at the COGEMA NPH pond in La Hague, in order to replace the old system of immerged "type E seals" and allow in situ verification. Preliminary drawings of a new "Sealing-Nut" have been provided for evaluation to COGEMA and Safeguards Directorate.

EXPLORATORY RESEARCH

DATA VISUALISATION OF SCIENTIFIC AND GEOGRAPHIC DATA

Specialised software and techniques have been developed inside ISEI to visualise and animate scientific data. Animation of time dependent data can be stored as digital video files. These files are then incorporated into networked multimedia presentations on the World Wide Web. In addition animation can be recorded to standard video-tape.

These techniques have been applied to oceanographic modelling data, meteorological data, geographic data and medical imaging.
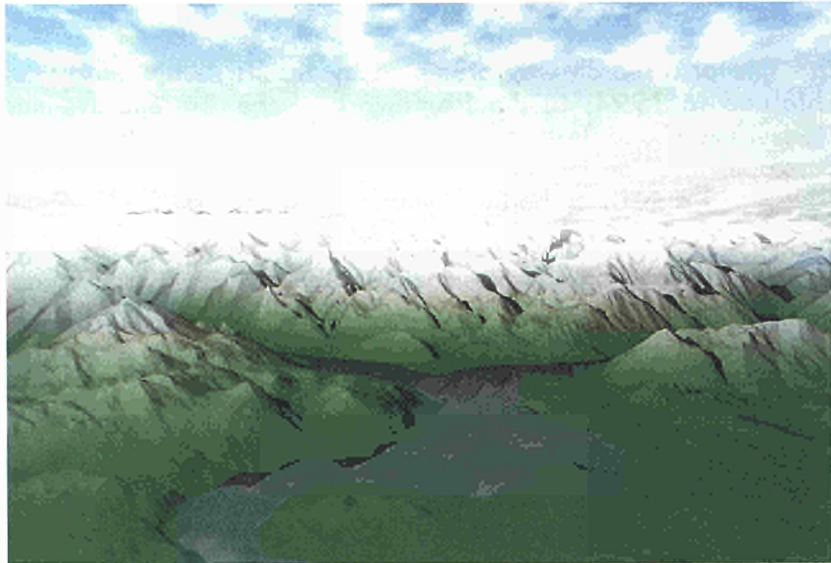
Fig. 2.32 A visualisation of a Digital Elevation Model of the Lago Maggiore looking from Ispra to Laveno. The data for all of Europe will eventually be accessible via the EWSE.

As an example of geographic visualisation, accurate digital elevation data for Europe has been used to render virtual fly-overs of central Europe. A World Wide Web interactive fly-over can be seen on the EWSE (http://ewse.ceo.org). A computer generated scene over Lago Maggiore, with fractal clouds is shown in Figure 2.32. The work in the medical imaging field concerns 3-d tomographic reconstruction of lungs from X-ray scanning data, and an automatic algorithm for edge detection. Furthermore a 3-d animation of breathing using keyframes derived from Chest X-rays has been achieved. Figure 2.33 shows an example reconstruction. This work is of direct interest as an aid to radiologists.

References:

/1/ A Digital Video System applied to Scientific Visualisation, C. Best and C. Macmillan, Proceedings of Eurographics ViSC Workshop, Chia, Italy, May 1995.
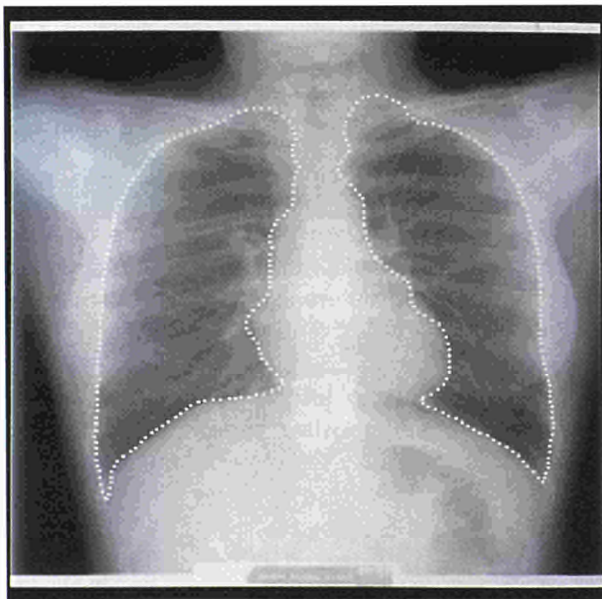
Fig. 2.33 3-d tomographic reconstruction of lungs derived from chest X-ray scans

DEVELOPMENT OF SMART COMPOSITE MATERIALS WITH EMBEDDED OPTICAL FIBRES FOR AUTODIAGNOSTICS

This line of research was prompted by results obtained in 1994, in the framework of the Measurement and Testing Programme, for the development of an interferometric optical strain gauge and also by a thorough literature search (performed for the preparation of a degree thesis) showing that:
— the need for structures having increased efficiency and reliability was motivating research in the field of smart materials, structures and sensors, but
— the availability of reliable and easy to use smart materials, enabling real time structural monitoring from inside the structure itself, was still far from being achieved.

Development of an interferometric optical strain gauge

The need for structures having increased efficiency and reliability has boosted research in the field of smart materials, structures and sensors. Within the latter field the development of systems capable of detecting stresses and strains with high precision is of great interest as strain sensors must often work in hostile environments characterised by strong electromagnetic (EM) fields, high temperature or corrosive chemicals and immunity to these factors coupled to high reliability, accuracy and ease of installation are often further mandatory requirements.

The device developed at ISEI (European Patent proposal N. 95830439.6) represents a possible technique to solve the above problems. This sensor is realised with a complete fibre optics interferometer based on the Michelson scheme; the optical fibre mirrored ends are obtained with metal deposition; optical fibres are positioned on a support using a specially designed mould able to block the optical fibres in the correct position.

A simple expression:
$$\Delta \Phi = 2\pi \, n \, \Delta l \, / \lambda$$

relates the phase change of the interferometric signal (DF) to both the refractive index (n) and the relative path change (Dl) of the two beams; such a path change occurs when the two optical paths are subjected to different strains (when a fibre is strained, its refractive index changes and its length changes as well).

This interferometric optical strain gauge offers easy installation on the structure to be tested at low production cost and guarantees the correct position of fibres leads within the transducer while keeping them very close to the structure surface. The other features are: corrosive environment compatibility; high temperature compatibility; high sensitivity and reliability; high resolution; point-like and directional detection; low transverse sensitivity; complete electromagnetic immunity both active (does not produce EM noise) and passive (it is not disturbed by EM noise).
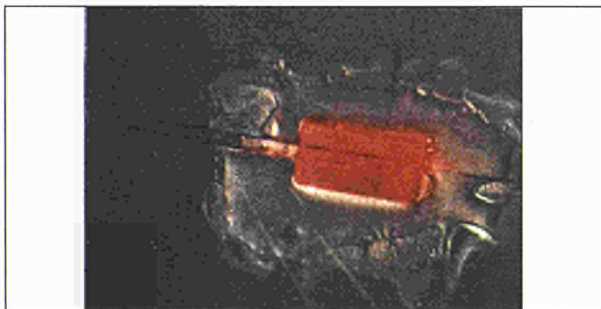
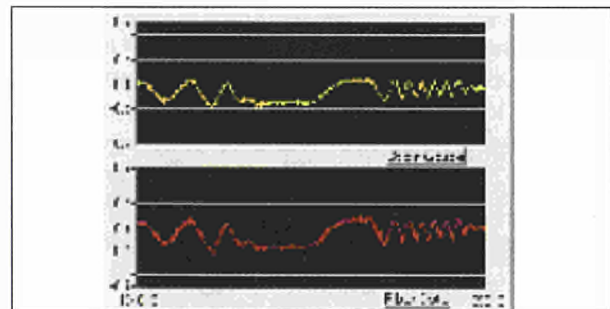Fig. 2.34 shows the optical strain gauge. Fig. 2.35 shows the static behaviour of the optical strain gauges compared with semiconductor strain gauge results and theoretical values.

Embedding of the optical strain gauge into composite materials

The possibility of embedding optical transducers into new composite materials has boosted research towards the field of smart materials enabling real time structural monitoring from inside the structure itself.

Composite materials are generally made of resin matrices reinforced with fibres. The fibrous structure gives the material different mechanical properties in different directions (anisotropy/ortotropy) and allows the designer to give more strength and stiffness to the material just where it is necessary. In continuous fibre composites, the proper positioning of the reinforce allows the material to host optical fibres without an increase of the notch factor.

Along this line of research, a smart composite material laminate was produced at ISEI (24 plies graphite/epoxy beam and Michelson based fibre optic strain transducers embedded in it) and tested.

Four fibre optic transducers were embedded in it between the second and the third unidirectional ply, allowing an easy detection of strain imposed by beam deflections. The optical scheme was based on a Michelson interferometer. Fig 2.36 shows a close up of the fibres entering the material.

The mathematical relationship between phase and strain takes into account the elasto-optic change effects due to embedding by means of a different Poisson's ratio. Both static and dynamic tests were performed and results compared to theoretical predictions and to strain values measured by conventional strain gauges bonded to the external surface of the laminate: the agreement was very good, particularly in the dynamic response: Fig. 2.37 shows the dynamic behaviour of one of the embedded sensors, whose signal spectrum is compared to that detected by the electrical one. As a conclusion, results supplied by the embedded sensing net of fibres confirmed its diagnostic capability and allowed the planning of future research steps.

The research on the development of smart composite material included effort in two relevant topics:
— improvement of in-fibre Bragg grating sensors
— development of a better performing software for fringe analysis

For the Bragg grating sensors, a design rule for the selection and fabrication of sensors with the desired sensitivity and wavelength has been developed. As far as the fringe analysis software is concerned, a software package has been designed and developed which is faster and more powerful than any commercially available tool.

Decisions and follow-up

As a consequence of the results obtained, the following activities are planned for 1996:
— the research on smart composite materials is being continued as a new Exploratory Research aimed at the development of a panel in smart composite material, with an embedded matrix of fibre optic sensors, and the relevant multiplexing and signal analysis tools for obtaining the real time tomography of the panel;
— a second Exploratory Research has been approved, aiming at the monitoring of pultruded composite beams using integrated optical sensors (possibly Bragg grating sensors);
— the new software for fringe analysis, together with substantial improvements obtained in the hardware of ESPI (Electronic Speckle Pattern Iterferometry), has lead to obtain a Third Party Work proposal in the field of Protection of Cultural Heritage

Fig. 2.34 The Optical Strain Gauge

Fig. 2.35 Static behaviour of the optical strain gauges compared with semiconductor strain gauge results and theoretical values
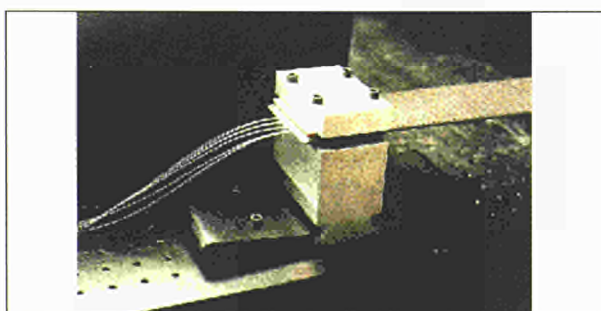
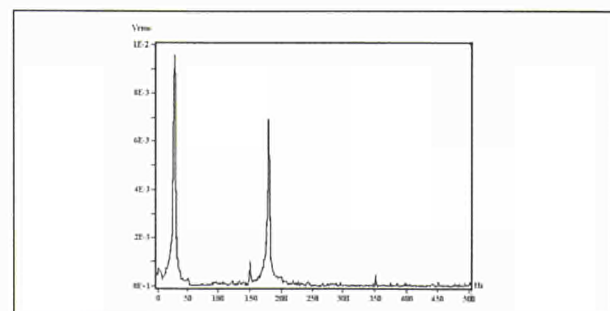Fig. 2.36 Close-up of the fibres entering the material

Fig. 2.37 Dynamic behaviour of one of the embedded sensors

OPTO-MECHANICAL SENSOR TECHNOLOGY FOR THE MEASUREMENT OF MICRO-VIBRATIONS AND TEMPERATURE VARIATIONS

The very origin of this project is constituted by the results of a 1991 Exploratory Research on "Light squeezing techniques", followed by activities, supported by DG XIII, on "Ultra high sensitivity interferometric sensors" and by three International Patents (PCTPE93/02978; PCTPE94/00050; PCTPE93/02977).

In this work devices based on the optical interrogation of a thin cavity interferometers allow micro-deformations and displacements of the cavity walls to be identified. Coupling of the device head to a mechanical or thermal variation allows such variations to be quantitatively analysed, and also allows the device to act as a controlled modulator. The sensitivity and broad bandwidth of such opto-mech-atronic devices, implemented using standard, potentially low cost optical, mechanical and electronic components, indicate their commercial potential as an emerging technology.

The activity of the last year has been focused on the problem of assuring linear outputs and wide dynamic range and compensating for ambient noise. A number of demodulation schemes have been examined. These include an active homodyne technique using feedback control to a piezoelectric actuator which drives one of the cavity plates. Passive homodyne techniques have also been studied where an active element on the cavity is not required. In order to understand and optimise sensor performance the mechanical, thermal and optical characteristics of the devices have been modelled. A principal feature of the devices is their low cost and potential for miniaturisation thus making them suitable for a wide range of industrial applications. Furthermore, through the incorporation of state-of-the-art components it is expected that the sensors will also prove a useful research tool for nano-measurements.

The Systems

All the devices have much in common. In particular all will use optical interrogation schemes to extract information about the cavity optical pathlength variation, and all will deal with similar background noise levels. Primary differences will take the form of geometry variations and tuning in order to enhance response to the particular thermo-mechanical input of interest.

In an effort to examine the effects of the optical interrogation system several implementations are being investigated including active and passive homo- and heterodyne techniques. Figure 2.38 shows a typical noise floor measurement using an active homodyne set-up.

It can be noted that in the figure the larger peaks correspond to known mechanical resonance and electrical line noise which are in principle suppressible. Therefore using a very simple opto-electronic system for interrogation of a cavity a noise floor in the worst case in the sub nanometer region and at best in

Fig. 2.38 Noise floor measurement using an active homodyne system

the picometer region can be measured in the 1-100Hz frequency bandwidth.

Applications and Advantages of these Systems

The technical characteristics and industrial relevance of these devices is very significant. The vibrometer, for example would find many applications, and lead to foreseeable technological innovation and the development of new instruments in many fields. In particular new markets in these areas pose technical problems that may only be solved using the high speeds and large information through-put offered by an all-optical system, including all the advantages of a non-contact non-destructive measurement system.

In the following some areas of application are listed:
— Vibration free platforms for industry: The manufacture of so-called 'Vibration Free Platforms' for use in the areas of tunnelling microscopy and microlithography, will require the development of hypersensitive vibration detectors. The inclusion of a control system using such vibration detector to reduce vibration noise will be of great importance in the area of micro-fabrication and engineering. Such application would include the writing of masks for the electronics industry using electron beam lithography or/and metrology applications using for example Atomic Force Microscopes, or Near-field Scanning Optical Microscopes, for testing and quality control.
— Differential pressure and temperature measurement: The largest markets today in sensors are in the measurement of pressure and temperature change. Both the technology and systems described here can be implemented to measure these changes The systems offers an extremely sensitive and low cost method to quantitatively measure very small changes in temperature gradient in a non-contact passive manner.
— Seismic and structural distributed monitoring: Another area of potential interest to industry and governmental agencies is the examination of the possibility of all-optical distributed vibration sensing. Any device which will result from this work will not be intended for mass production but rather for specialist niche markets. This will be primarily due to the high cost of the system resulting from the necessity of using a highly stable, low noise quality light source to achieve sensitivity enhancement. However the possibility to reduce over all cost by applying a single light source for measurement at many points, and the application of such a network of distributed sensors to, for example, seismic monitoring, could provide significant real monitoring and predictive advantages.
— Active damping and smart structures and materials: The ability to co-locate sensors and actuators to perform active damping are subjects of extreme current interest. Given the ability to perform many of the tasks described in this report it is expected to be able to implement actively damped structures for use in many industrial situations. Such structures could include civil, aviation or space borne structures, or devices for which active vibration or thermo-mechanical control is essential.
— Scientific Community - gravitational experiments: Based on current laboratory results and theoretical calculations, it is reasonable to expect that a hypersensitive detector can be manufactured, costing an amount equivalent to the current most expensive commercial accelerometers, but with much higher sensitivity. Such a device would be of particular interest to the scientific community. Currently large sums of money are being invested in devices to measure such low frequency weak vibrations, both in Europe (VIRGO, the European Gravitational Wave Observatory, Italy-France, and GEO, Germany-UK) and elsewhere (LIGO in the USA, and TU Japan). A specially refined form of our device could be attached to the current VIRGO system to either 1) improve its measurement performance, and/or 2) help in the stabilisation of that system. Since some of these gravitational detectors are kilometres in length, and despite being long running and very expensive projects, at this point in time many of the technological problems encountered in this work are still unsolved.

Decisions and follow-up

As the consequence of the results obtained, the following activities are planned for 1996:
— the research on the interferometric sensor for the measurement of mechanical microvibrations has lead to the preparation of a new Exploratory Research project (selected for funding) on "Monitoring of seismic vibrations", aiming at the development of an integrated system for early detection of increased seismic activity;
— the development of industrial prototypes of the three patented interferometric devices will be supported in 1996 by DG XIII (three projects have been selected for funding).

DEVELOPMENT OF A PARTIALLY COHERENT LIGHT PROFILOMETER

A Patent Proposal has been presented (European Patent proposal N. 95830438.8) for an interferometric device, based on partially coherent light speckle contrast variation, for three dimensional profilometry of relatively large, optically rough objects.

The key features of the system are: large depth range; variable resolution (from about 3 to 100 microns); no need to displace the object; real time elaboration of three dimensional data acquired from the whole inspected area; usable on objects of metallic as well as non metallic material and surface roughness of the order of the light wavelength (visible or near infrared); inspected surface of some squared centimetres.

In comparison with prior solutions, the new profilometer has the advantages that: 3D profiles can be obtained with a vertical resolution dependent only on the temporal coherence length of the used light, so that it can be easily modified by changing the spectral band of the interference filter; the roughness of the object's surface is not a source of noise, as it was white light interference methods based on fringe envelope evaluation; the acquisition procedure is based on a real time digital image subtraction and do not require sophisticated software and large computer power for 3D profile reconstruction; no object movement is required, so parts of large and heavy objects can be inspected.

The development of an industrial prototype is planned for 1996 under the support of DG XIII.

SUSTAINABILITY ASSESSMENT OF ENERGY SYSTEMS

In the light of increased scientific knowledge and public awareness about the adverse effects of power generation to man and nature, the world energy system is in a state of transition. Currently, Mediterranean countries are faced with strategic questions regarding their future energy supply and demand that will have to be answered by the end of the century. This work /1/ aims to:

— highlight the current energy picture in the Mediterranean basin;
— identify the environmental concerns associated with this energy system;
— review the locally available energy resources;
— finally, review and assess the currently available and future energy technologies with regard to their efficiency and their role in fuelling the sustainable development of the countries in the region.

The above analysis is done taking into account the current trends of population and energy intensity evolution in the Mediterranean countries, attempting, thus, to provide a useful and comprehensive framework for sustainable energy policy in the region and for energy conservation at the European level. The task of reviewing the relevant technological solutions and identifying the main factors and steps required for technology transfer and implementation of a sustainable and efficient European energy policy has been undertaken /2/. The analysis is based on an enlarged view of technological risk including plant safety, ecological vulnerability and macrosocietal compatibility of technology. Following this multi-faceted definition of risk, a systematic approach towards integrated risk assessment and the related conceptual tools for risk internalisation into the technology development and regulation process is currently under development and its key elements are delineated /3/.

References:

/1/ D.A. Sarigiannis, F. Andritsos, The impact of new energy technologies on the Mediterranean basin: the sustainability perspective, *Fresenius Environmental Bulletin* (forthcoming).

/2/ D.A. Sarigiannis, F. Andritsos, Energy conservation and economic development: new synergisms in the private sector, *Proc. 2nd International Conf. on Environmental Technology for the Mediterranean - HELECO'95* (1995), Athens, Greece.

/3/ D.A. Sarigiannis, G. Volta, A new concept for risk-based technology development and regulation: areas of its applicability, *Proc. 1995 ASME/JSME Pressure Vessels and Piping Conference*(1995) Hawaii, USA.

3 COMPETITIVE ACTIVITIES

COMPETITIVE SUPPORT
TO COMMUNITY POLICIES

SUPPORT TO THE COMMUNITY ENVIRONMENTAL POLICY (DG XI)

Analysis of the Methods used in the Environmental Impact Studies of Installations for the Treatment and Disposal of Toxic and Dangerous Waste in EU Member States

Introduction and aims of the Study

The 1993 five year review of the implementation of EC Directive 85/337/EEC /1/ on the Environmental Impact Assessment (EIA) of certain public and private projects revealed that:

" ... in a number of Member States, only a minority of EISs are of satisfactory quality" /2/.

As part of its response to the five year review, DG XI requested ISEI to undertake a study to identify the common approaches and differences in a representative sample of Environmental Impact Studies (EISs) submitted under Annex I.9 of the EIA Directive in the twelve 1994 Member States of the European Union. The type of projects considered are waste disposal installations for the incineration, chemical treatment and landfill of toxic and dangerous waste. Projects of this type are among those most frequently submitted to competent authorities under the EIA Directive and are of particular concern to the public, given their potential impact.

The study examines the environmental factors, environmental indicators, impact prediction methods, evaluation criteria, uncertainty analysis methods and risk assessment used in EISs of Annex I.9 projects /3/4/. The main aim of the study is to contribute to improving the quality of the EISs submitted in the Member States.

Methodology

The methodology followed is composed of four main stages /5/:
— collection of EISs from 12 Member States;
— preparation of Identification Forms for each EIS classifying the main information;
— preparation of a Report on each EIS considered in the Study. The Report analysed the extent to which the EIS considered environmental factors in the assessment of the impact of the

development. The environmental factors are: human beings, air, climate, surface water, soil and ground water, landscape, land use, flora and fauna, ecosystems (interactions), noise, material assets, cultural heritage, socio-economic system and traffic. For each of these factors the environmental indicators, impact prediction methods, evaluation criteria, uncertainty analysis methods and risk assessment used in the EIS were analysed.
— preparation of the Final Report detailing main findings and recommendations to improve the quality of EISs.

The Ministries of the Environment of the 12 Member States and about 40 organisations in the public and private sector were contacted to obtain EISs produced for incinerators, landfills, biological and chemical treatment installations. A total of 33 EISs were received from 11 out of the 12 Member States, of which five EISs were not appropriate for the Study and were therefore not considered in the analysis. The EISs are written in nine different languages and concern 35 installations (some plants include more than one installation (Table 1)).

Main findings

The Study is the first of its kind which has used a systematic approach to analyse a significant number of EISs (35) of four types of installations from EU Member States (11). The main findings of the Study show that for most of the environmental factors considered, environmental indicators are not usually specified or clearly defined, with the exception of the indicators for air, water, soil, noise and land use. Quantitative indicators are considered more explicitly than qualitative indicators. The environmental indicators identified and used in the baseline survey often differed from the indicators used in the prediction of impacts.

Objective prediction methods are generally used in the cases where the impacts are easily quantifiable. These objective methods can be divided into two broad categories: (i) simple or simplified methods involving the use of simple physical or mathematical models and (ii) more complex methods involving the

use of complicated mathematical models or formulae. Objective prediction methods are mainly used in the prediction of impacts on the factors: air, soil and ground water, landscape, noise and traffic. In the majority of cases relating to more complex objective prediction methods, the rule usually adopted in the EISs is to discuss the method in very general terms and to present the final results, minimising the details of the intermediate stages. In the case of qualitative indicators, subjective judgement is often used as a prediction method.

The majority of the EISs consider only direct impacts of the proposed development on the various factors. Indirect impacts are considered in the case of human beings, flora and fauna, soil, land use and traffic

Table 1
Number of EISs received and number of installations considered
in the analysis for each Member State

Member State	No. of EISs received (No. of plants)	No. of EISs not considered in the analysis	No. of installations considered in the analysis** (Total = 35)			
			Incineration	Landfill	Chemical treatment	Biological treatment
Belgium, Flemish	3	-	1	1	1	-
Belgium, Walloon	2	1	-	-	1	-
Denmark	2	-	1	1	-	-
France	3	-	2	2	-	-
Germany	2	2	-	-	-	-
Greece*	1	-	1	-	-	1
Ireland	1	-	1	-	-	-
Italy	5	-	3	2	2	-
Luxembourg	0	-	-	-	-	-
Netherlands	3	-	1	1	1	-
Portugal	2	-	-	1	1	-
Spain	7	2	3	1	1	2
United Kingdom	2	-	2	-	1	-
Total	33	5	15	9	8	3

* The EIS from Greece concerns industrial non toxic/dangerous waste. It has been considered in the analysis because it is the only EIS from this Member State.
** Some EISs include more than one installation.

with the use of the results obtained for other factors, such as air and water quality. Cumulative impacts are discussed in only one EIS, in relation to the impact on land use and soil. No EIS considers synergistic environmental impacts. Transboundary impacts are not considered in any EIS. This may be due to the fact that the type of projects in the analysis are concerned with a relatively limited area and none of the EISs is for a development which is located close to an international frontier.

The evaluation criteria used in the EISs are often based on national, European and international standards, especially for the quantifiable impacts such as those on air, water, soil, noise and human beings (toxicity). For other factors, the evaluation criteria are based on zoning legislation (flora and fauna, land use, landscape and cultural heritage). For the qualitative impacts the criteria used are often vague and mostly subjective. References for the particular legislation used to evaluate the impacts are not always stated within the EISs.

Uncertainty analysis arising in the prediction of impacts from a development is undertaken in almost half of the EISs. Uncertainties are discussed for six environmental factors: air, surface water, soil and ground water, landscape, land use and noise. The only method used in all the EISs is the worst case scenario approach. Air is the factor for which uncertainty is discussed in more detail and is mainly considered in EISs of incineration installations, due to gaseous emissions from the stack. Uncertainty in the baseline data is not discussed in any EIS.

Some general comments are given in the Study in relation to the structure and content of the EISs: (i) the description of the proposed plant is not always comprehensive, (ii) the relationship between the indictors used in the baseline situation, the indicators used in the prediction of environmental impacts and the criteria used to evaluate the predicted impacts, is not always clear, (iii) the wider area which the EIS covers in its assessment of environmental impacts sometimes differs in the baseline and in the prediction of the same factor and is often not justified, (iv) an overview of the procedure followed in terms of factors considered, indicators used, prediction methods applied and evaluation criteria adopted is not included in any EISs.

A list of recommendations is provided in relation to the conclusions made in the Study. The main recommendations concern /6/:
− certain environmental factors which should be specified in legislation;
− definition of environmental indicators mainly for qualitative factors such as human beings, flora and fauna, landscape;
− justification of the wider area covered by the baseline survey and relevance of the data provided in the discussion of impacts;
− more detailed explanation of impact prediction methods used in the EIS;
− improvement of the level at which uncertainty analysis is discussed within the EIS;
− definition of objective criteria to evaluate qualitative factors, where possible.

Finally, recommendations for further research within the area of EIA are outlined, including the production of Guidelines for the preparation of EISs and a handbook on environmental indicators for EIA.

References:

/1/ Commission of the European Communities: Council Directive of 27 June 1985 on the *Assessment of the Effects of Certain Public and Private Projects on the Environment*. (Directive 85/337/EEC). Official Journal of the European Communities No L175/40-48, 5.7.1985.

/2/ Commission of the European Communities Report from the Commission on the implementation of Directive 85/337/EEC on the *assessment of the effects of certain public and private projects on the environment*. (COM(93) 28 final - Vol. 12). Brussels, 2 April 1993.

/3/ A. G Colombo (ed.): Environmental Impact Assessment. Kluwer Academic Publishers, Dordrecht, 1992.

/4/ A. G. Colombo and G Premazzi (eds.): Proceedings of the Workshop *"Indicators and Indices for Environmental impact Assessment and Risk Analysis"*, Ispra, 15-16 May 1990, Report EUR 13060 EN (1990).

/5/ A. G. Colombo, A. Artola, G. Haq and I. Melaki: The ISPRA study on the methods used in Environmental Impact Assessment of Disposal Installations for Toxic/Dangerous Waste in Environmental Impact Assessment Methodology and Research - Third EU Workshop on Environmental Impact Assessment, Delphi 1994.

/6/ A. G. Colombo, A. Artola, C. Gervasi, G. Haq, I. Melaki: An Analysis of the Methods Used in the Environmental Impact Studies of Installations for the Treatment and Disposal of Toxic and Dangerous Waste in EU Member States. (1996) EUR Report (*in progress*).

SUPPORT TO THE COMMUNITY TRANSPORT POLICY (DG VII)

European Co-ordination Centre for Aircraft Incident Reporting Systems

ECC-AIRS (European Co-ordination Centre for Aircraft Incidents Reporting Systems) Completion of the pilot version and its presentation to European Civil Aviation Authorities.

Introduction

Around 1990 a number of studies in the field of accident investigation and incident reporting systems were carried out on behalf of the European Commission (DG VII: Transport). In a study entitled "Community Air Safety Information System" it was proposed to bring together the knowledge of the mandatory incident reports in various Member States. The study recommended to set up a European Co-ordination Centre for the mandatory Aircraft Incident Reporting Systems (ECC-AIRS). ISEI was given the task to generate a proposal, including a functioning prototype solution, for a system that is able to logically connect the various systems related to aircraft incident reporting in the different Member States. The main objectives of this prototype are to assess the feasibility of a central incident database containing information from all existing reporting systems and to verify the applicability of this central system, possibly in an adapted form, as a technical solution for those Member States that actually do not have an automated incident reporting system running.

A review of the ISEI proposal, by DG VII and the participating Member States (Belgium, Denmark, France, Germany, Italy, Portugal and the United Kingdom) resulted in a formal agreement (July 1992) between the JRC and DG VII to start the pilot project. In the period 1993-1994 the system's environment had been purchased and set-up, the architecture of the database system was implemented, various front-end components were designed and tested and the first occurrences were imported and stored in the database.

Achievements in 1995

The first half of 1995 has been used to finalise the first beta release of the system and to import the complete set of more than 30 000 existing occurrences from the period 1985-1993. In July a slightly reduced version of this release has been distributed to the ECC-AIRS Steering Committee members for evaluation .

In October 1995 the ECC-AIRS Steering Committee, based on the work done by the JRC, assessed the feasibility of an integrated European aircraft incident/accident database. Technical experts of seven Member States, a representative of DG-VII (Transport) and an observer from ICAO's Accident Investigation and Prevention section concluded that the pilot system as developed by ISEI, demonstrated the feasibility of such a concept.

In a common statement the Steering Committee agreed that the ECC-AIRS pilot system could be the foundation for a production version of an integrated European incident/accident database. Furthermore the Steering Committee regards the ECC-AIRS system as an essential building block in the development of advanced analysis techniques, since it has the
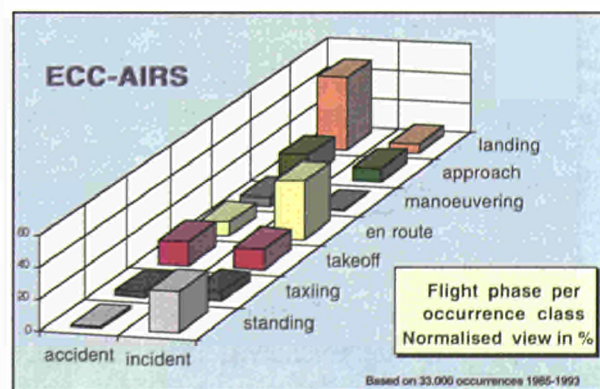
Fig. 3.1 A three-dimensional plot showing the normalised view of the occurrences per flight phase.

capability to bring together vast amounts of data from several sources.

The current system stores more than 33 000 occurrences originating from three incompatible sources, in a relational database. A user-friendly, MS-Windows based front-end allows for data-retrieval, data-entry, data-exchange and data-analysis. The software that has been developed in the ECC-AIRS project could be exploited by the European Commission. It can serve as an ICAO compatible, automated aircraft incident/accident reporting system for countries that do not yet have automated facilities.

As an exempla of simple data presentation, in Figure 3.1 a three-dimensional plot is reported showing the normalised view of the occurrences per flight phase.

Planned future activities

Until May 1996 work will be performed (under the support of DG XIII) to create the second beta release of the ECC-AIRS system. In the same period a feasibility report will be produced in collaboration with DG-VII. This release will be distributed to the ECC-AIRS steering committee members and will include a sample of incident data. The application without the data-sample can be distributed to any party interested.

After May 1996, a 12 month activity should start, under the support of DG VII, devoted to the development of a production system. The possible deliveries of this last activity will be:
- a central database containing all occurrences provided by the existing EU databases;
- a set of installable applications that allow organisations to insert, retrieve and exchange occurrence information;
- documentation that allows installation maintenance and continued development of the ECC-AIRS software and database contents; this will include agreements with the existing reporting systems on the procedures to integrate their new data.

In the course of 1996 a political decision is also expected by the Commission on what role the ECC-AIRS system shall play in the Commission's aviation safety programme for the coming years.

References:

/1/ W.Post "European Co-ordination Centre for Aircraft Incident Reporting Systems - Project Progress Report N.3" Technical Note I.95.06, January 1995
/2/ W.Post "European Co-ordination Centre for Aircraft Incident Reporting Systems - Project Progress Report N.4" Technical Note I.95.135, August 1995

SUPPORT TO THE COMMUNITY INDUSTRIAL INNOVATION POLICY (DG XIII)

Interactive Mobile Surveillance System

Following ISEI's work in Mobile Robotics for Remote Surveillance /1/2/ (executed under the framework of the Safeguards programme), the project IMSS (Interactive Mobile Surveillance System) was approved under the framework of DG-XIII's Technology Valorisation Programme.

The scope of the project is to validate an interactive mobile surveillance system and overcome limitations of conventional surveillance relying upon fixed sensing capabilities. Such a system can travel to specific areas to perform detailed examinations on a regular basis upon the request of a human operator or whenever a fixed surveillance equipment indicates an alarm. A key aspect to this project is that not only
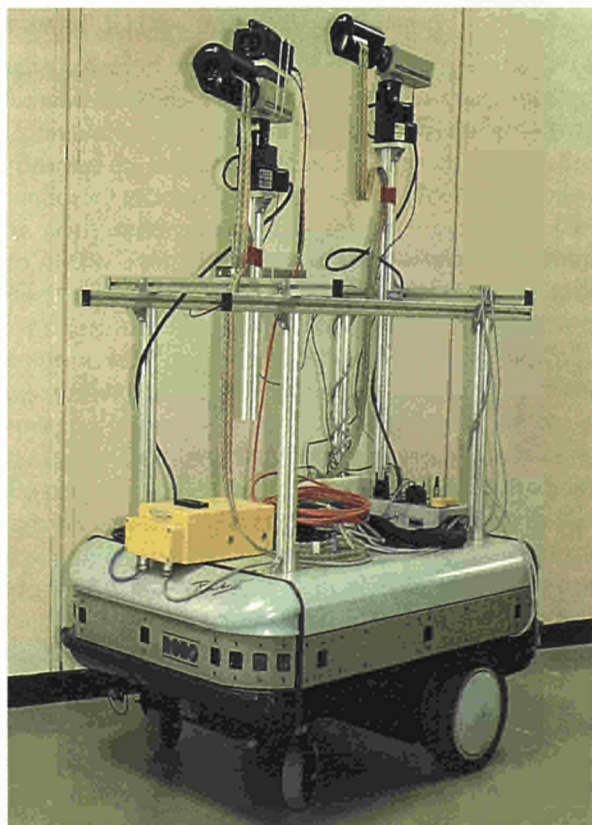
Fig. 3.2 ISEI's remote surveillance robot equipped with TV cameras, motorised zoom and focus lenses, and computer controlled pan-and-tilt units.

it can add new functionalities to existing commercial surveillance systems, but, and perhaps the most important, it opens the way to new, "intelligent", sensor-based surveillance applications. Indeed, both the hardware and software rely on open architectures allowing for modularity, flexibility and expandability, which makes the design of surveillance tasks targeted to specific applications possible.

An IMSS must deal with the technologies enabling mobile surveillance (e.g., architecture, sensors, robot navigation) as well as with an appropriate human-computer interaction. The final system will be independently tested in three different environments such as office buildings, wide indoor areas (e.g., airport hall or casino) and wide open areas (e.g., parking lots). Figure 3.2 shows ISEI's remote surveillance robot equipped with TV cameras, motorised zoom and focus lenses, and computer controlled pan-and-tilt units.

References:

/1/ Gonçalves J.G.M., Nunes J., Santos V. - "An Interactive Remote Surveillance System", Proc. 17th ESARDA Symposium on Safeguards and Nuclear Material Management, Aachen, May 1995.
/2/ Nunes J.J., Gonçalves J.G.M. - "An Interactive Mobile Surveillance System", JRC Technical Note No. I.94.164, December 1994.

Special Instrumented Implements for Use on Site by Inspectors

ISEI-Ispra has launched the study and development of special instrumented implements to facilitate the inspector work on site and making it more accurate. This equipment has been devised and specified by ISEI and should be used to check and record the mechanical conditions (parameters) during sealing-bolts installation by inspectors. This work is carried out under the Valorisation Programme of the DG XIII and is shared by JRC-Ispra and a French company: FGP, specialised in measuring devices, to which the study of a prototype has been committed. This study implies a complete adaptation to the actual implements on site.

SUPPORT TO THE COMMUNITY ENERGY POLICY (DG XVII)

Support to the SAVE Programme

Energy consumption and ventilation performance data were studied through the SAVE-HELP project (CSA). Analysis of experimental data from monitoring occupied houses was reported and will lead to a simplified calculation tool. The project started in January 1995 and will run until November 1996

Least Cost Planning

In the absence of formal approval of the Competitive Support Activities for 1995 (contracts were signed only in late December 1995) some work was, nevertheless, carried out in order to ensure continuity with the work initiated in previous years.

In particular, throughout the whole of 1995, the ISEI continued to participate in the work of the IEA in the field of the Demand Side Management (DSM) (Task 1). In this Task 1, six countries (United States, Denmark, Spain, Sweden, The Netherlands and Korea) and the European Commission collaborate in setting up an International Database on Energy Efficiency Programmes, called INDEEP. According to DG XVII's requirements, this database should be one of the tools the European Commission is setting up as support for the utilities in the future European energy market. The activities carried out by ISEI during 1995 were the following:
- preparation of and participation in the Workshop on DSM Task 1. (Vienna, 25-27 January 1995) and in the Task 1 Expert Meeting on 24 and 27 January;
- improvements of the Data Collection Instrument (DCI) for gathering programme data;
- participation in the Annex 1 Expert Meeting in Mandelieu and in the ECEEE Summer Study on DSM;
- review of available intermediate/final reports of DSM/SAVE contracts;
- involvement of main European utilities which had received a SAVE/DSM contract for the creation of a consulting network and for the supply of data for INDEEP;
- preparation of the table and codes of energy saving technologies;

- collection and loading into the database of program data from SAVE contractors;
- participation in the IEA/DSM Executive Committee DG XVII and in the Task 1 Expert Meeting at Fukuoka (Japan) ;
- attendance at the DA/DSM Conference in Rome, 21-23 November 1995;
- preliminary analysis of INDEEP database for discussion at the next Task 1 Workshop to be held in early 1996.

As can be seen from the above, follow-up of the SAVE/DSM programmes started during 1995. Of the 49 DSM programmes financed by DG XVII during the SAVE I period (1991-1994), some were mainly feasibility studies, while others were launched as pilot or full scale demonstration programmes. The latter ones have been considered for data gathering for the database INDEEP. All have been assessed for their content. A further analysis and follow-up action will be carried out in 1996, to the request of DG XVII.

Building Energy Certification in Europe

The success and interest created by the Seminar on Building Energy Certification, organised by the ISEI in Sophia-Antipolis (France) in June 1994, produced effects also during 1995. In fact, the ISEI was requested to present main technical papers at the two following meetings:
- "Energy Savings in Buildings: local experiences within the framework of EU strategies", Trento (Italy), 19 May 1995 /1/ and
- European Seminar on "Energy labelling of Buildings in Southern European Countries", Seville, 7-8 September 1995 / 2/.

While Energy Certification in Buildings seems to be developing in more and more countries, as far as heating and hot water energy in residential buildings is concerned, conceptual difficulties still remain for defining acceptable procedures for certification in other building categories (e.g. offices, schools, commercial premises, etc.) and other end-uses (electricity, cooling energy).

The introduction to the market of new processes, new products and general economic growth are driving mechanisms which increase energy demand everywhere. This growth can be mitigated or balanced only if strong measures for the rational use of energy are developed and implemented.

Presently, in all European countries and especially in those of Southern Europe, there is a strong increase in the cooling energy requirement. This occurs particularly in the service sector (office, commercial, tourism buildings, etc.), due to continuous growth in the activities of these economic sectors.

The combination of bad architectural designs with the use of energy guzzling appliances during the eighties led to a generalised worsening of energy and environmental conditions. The American standard Energy Star label, adopted by the US public administration and similar initiatives under development in other industrialised countries, will certainly have an effect on the design of future appliances. The European Commission with the SAVE programme, which tackles all kinds of end-uses in buildings, will contribute to the production of more energy efficient building components, equipment and appliances.
The development of any scheme of energy certification for different building categories and climates requires a careful analysis of two basic issues:
— the definition of standard comfort conditions;
— the energy services available.

Different requirements of comfort conditions and energy services can lead to large differences in energy consumption levels. The problem of identifying acceptable and agreed comfort conditions is strictly linked to the quality of the construction, in terms of ventilation rate, fenestration and openings, internal lay-out and hygienic conditions. The number of energy services and appliances in operation in a building has a direct impact on the air-conditioning system design choices. Mechanical ventilation in many cases can only mitigate the effects of bad design by means of an increase in electricity consumption.

Finally, there is a close link between energy consumption and environmental impact of buildings. Schemes for the "green" labelling of buildings are becoming more and more popular in Europe and important R&D efforts are underway in this field. If the paradigm of environmental protection is the one which dictates new norms (for instance, SAVE Directive) then buildings must be analysed under a more comprehensive environmental assessment and not by focusing only on energy aspects.

Certification, applied to any product increases its market acceptance and transparency. The application of such a concept to the building sector cannot be considered an issue for energy technicians and bureaucrats. On the contrary, the introduction of Building Energy Certification is a very difficult task, requiring a large number of non-technical barriers to be overcome and the involvement of many social actors concerned. Therefore, together with the development of technical aspects, the development of socially viable implementation techniques must be considered as an important part of this initiative.
Although Building Energy Certification schemes still need to be implemented and tested in many European countries, it is nevertheless time to:
enlarge these schemes to all building categories and energy end-uses;
— link Energy Certification to other types of labelling, such as "environmental or green" labelling and building quality certification;
— involve other social actors (such as Credit and Loan Institutes, Real Estate dealers, builders, manufacturers, etc.) in order to improve the social acceptance of Building Labelling techniques.

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/1/ Flavio CONTI , "La Certificazione della Qualità finale dell'edificio sotto il profilo energetico". Convegno ARGE-ALPe Provincia di TRENTO su: Il risparmio energetico in edilizia: le esperienze locali nell'ambito delle strategie comunitarie", Trento, maggio 1995.
/2/ Flavio CONTI , "Building Energy Certification: State of progress and implementation problems for southern European countries", European Seminar on "Energy Labelling of Buildings in Southern European countries". Seville, Spain, September 7-8, 1995

Support to the THERMIE Programme

Monitoring of Photovoltaic (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. During 1995 monitoring data from more than 20 projects were analysed and presented in ca. 150 monthly and 20 intermediate and final performance reports. The data are stored on-line on a Sun Sparc 10 computer 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.

A particular achievement in 1995 was the transformation of the data files resulting from monitoring EC-funded PV projects since 1983 into a new common format (NUFF = New Unified Field Format).

The original files existed in a number of different structures reflecting the progress in monitoring technology. Together with the common format new tools were developed for extracting detailed and specialised information from these data.

ESAS participated in the THERMIE PV contractor's meeting in Freiburg together with the project managers, representatives of the European PV industry and the programme co-ordinators from DG XVII.

Another significant contribution to the DG XVII PV programme consisted 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.

The highlights of these activities in the field of PV plant monitoring were presented at the 13th European Photovoltaic Solar Energy Conference in Nice.

Assessment work of Targeted Projects and the Solar Power Plan

The Solar Power Plan, has been organised and supported by two European expert meetings focused on identifying the technical project for producing electricity, using concentrating solar collectors. Programme presentations were made at Conferences held in Lamezia Terme and Rome. An expert meeting on "Urban planning" was organised in Brussels and there was participation in the following conferences and meetings:
- "Intelligent Buildings " in Barcelona and Paris.
- "First World Conference for Sustainable Tourism" in Lanzarote
- "International Conference on Solar Architecture for the Mediterranean Area" in Athens
- "Solar Energy Forum on Technical Barriers to Renewable Energy" in Seville
- "European advisory expert working group on RUE in the building sector " in Brussels

References:

/1   R. Colombo and coll. - Manuel pratique pour la conception et la mise en oeuvre d'opération domotiques et immotiques (SPI 95/10)
/2/ R. Colombo, A. Prins and coll. - Technological potential for energy efficiency improvements in industry (SPI 95/35)
/3/ R. Colombo and coll.- Manuel de conception - Architecture solaire Passive pour la Région Mediterranéenne (SPI 95/58)
/4/ R. Colombo - Present status and trend of solar thermal conversion technologies (SPI 95/62)

Support to the ALTENER Programme

Work was focused on the organisation of the CEN Working Group TC 312 meeting in JRC Ispra for which a working paper was prepared. A working paper was also prepared for the Conference on Guarantee of Solar Results in Perpignan There was participation in the CEN/TC 321 meetings held in Fribourg, Cologne and Delft.

Advanced Communication Technologies & Services

Following ISEI's expertise in 3D reconstruction from real world scenes /1/2/3/4/5/, the RESOLV (Reconstruction using Scanned Laser and Video) project was approved within the framework of the ACTS programme. The three year project officially started in September 1995, and will be executed by the following consortium:

— BICC (UK):	(prime contractor and project manager)
— University of Leeds (UK):	(partner)
— Robosoft (F):	(partner)
— INESC (P):	(partner)
— JRC-ISEI:	(partner)
— Instituto Superior Técnico (P):	(JRC's associated partner)

The objectives of RESOLV are:
— the development of an autonomous system for creating a 3D textured model of a real world scene; and the demonstration of these models for:
  • *construction industry*: 3D information for building maintenance, progress monitoring of building sites, facilities management, refurbishment;
  • *virtual reality*: rapid production of realistic Virtual Environments;
  • *social tele-presence*: predefined surroundings for inserting real time video of remote people in teleconferencing and tele-working applications.

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/1/ Sequeira V., Gonçalves J.G.M, Ribeiro M.I. - 3D Modelling of In-Door Scenes using Laser Range Sensing, Proc. 4th IAPR International Workshop on Machine Vision Applications, pp. 315-318, Kawasaki (Japan), December 13-15, 1994

/2/ Gonçalves J.G.M., Sequeira V., Ribeiro M.I. - "3D Scene Reconstruction for Design Information Verification", Proc. 17th ESARDA Symposium on Safeguards and Nuclear Material Management, Aachen, May 1995.

/3/ Sequeira V., Gonçalves J.G.M., Ribeiro M.I. - "3D Scene Modelling from Multiple Range Views", Proc. SPIE Conference Videometrics IV (part of Photonics East'95), vol. 2598, pp.114-127, Philadelphia, 22-26 October, 1995.

/4/ Sequeira V., Gonçalves J.G.M., Ribeiro M.I. - "High-Level Surface Descriptions from Composite Range Images", Proc. IEEE International Symposium on Computer Vision, pp. 163-168, Coral Gables - Florida, 19-21 November 1995.

/5/ Sequeira V., Gonçalves J.G.M., Ribeiro M.I. - "3D Environment Modelling Using Laser Range Sensing", in Robotics and Autonomous Systems, vol. 16, No. 1, pp. 81-91, November 1995.

TINCA Project

It belongs to the COPERNICUS program and its full title, which indicates its objectives, is "Enhancing Technological Awareness and Technology Transfer in the Area of Advanced Intelligent Computer Systems for the Assessment of the Remaining Life, Reliability and Safety of Power Plant Components". The leading institute is the Staatliche Materialprüfungsanstalt (MPA), Stuttgart University.
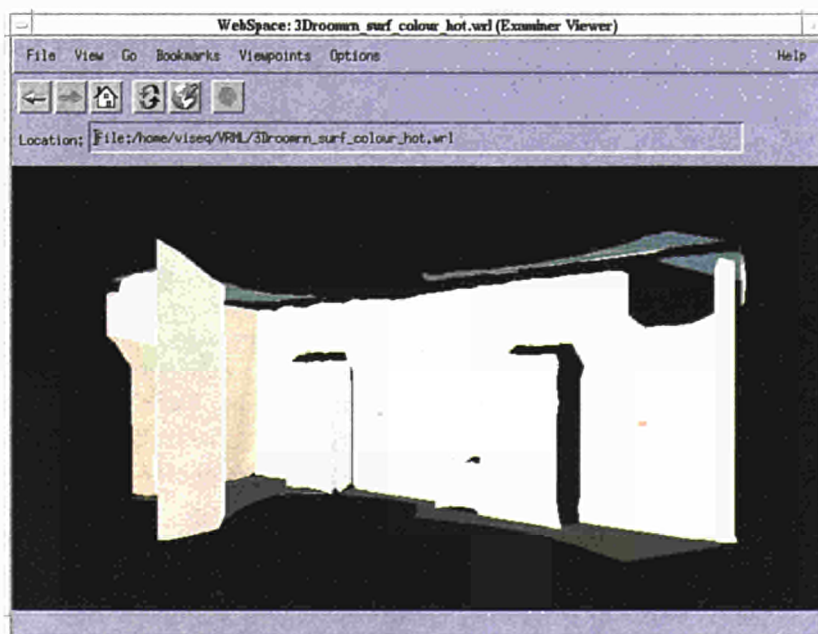
Fig. 3.3 Shows a 3D reconstructed model of a laboratory scene using a VRML browser

The partners are:
- MPA (Staatliche Materialprüfungsanstalt), University of Stuttgart, Germany;
- ISQ (Instituto de Soldadura e Qualidade), Cabanas-Leiao, Portugal;
- JRC (Joint Research Centre, European Commission) - Ispra - Varese, Italy;
- KORONA, Ljubljana, Slovenia;
- DME (Department of Mechanical Engineering), University of Miskolc, Miskolc, Hungary;
- EROKAR (Department for Material Testing and State Control), Budapest, Hungary;
- LEN (Public stock Company LENENERGOREMONT), St.Petersburg, Russia.

The tasks of ISEI are:
- establishment of a TINCA booth at Ispra. This is envisaged as an information pool (of EU programs, TINCA leaflets, ...), for which some staff members will be responsible, and which will take certain type of actions (TINCA hotline, seminars...);
- updating and presentation to the TINCA partners of the actual EU research programs, indicating also interest and possibilities for the Eastern European countries.

SMALL PUNCH Projects

It belongs to the Copernicus Program. Its full title is "Small Punch Test Method Assessment for the Determination of the Residual Creep Life of Service Exposed Components". The leading institute is the Staatliche Materialprüfungsanstalt (MPA) Stuttgart University.

Life time assessment of high temperature pressurised components is a critical issue in the safety and reliability of power plants. In Central and Eastern Europe in particular, the push to comply with new regulations for environmental protection and safety while maintaining supplies to industrial and domestic consumers demands effective techniques for the estimation and monitoring of remnant power plant life. Currently, the principal tool for engineering evaluation of residual creep life consists of harvesting sufficient material to produce test specimens for accelerated creep tests at high temperature. The Small Punch (SP) test has been developed as a miniature specimen test methodology to minimise the impact of harvesting material from active components

under investigation. At ISEI, work is underway to utilise Electronic Speckle Pattern Interferometric (ESPI) techniques to allow accurate on-line monitoring of full field disk-specimen deformation at elevated test temperatures. This will improve the accuracy of load-deflection test data while giving an insight into disk failure modes.

This project is being carried out in partnership with:
- MPA (Staatliche Materialprüfungsanstalt), Stuttgart, Germany.
- CISE (Centro Informazioni Studi esperienze), Segrate-Milano, Italy
- JRC (Joint Research Centre, European Commission), Ispra - Varese, Italy
- IRM (Institute of Physics of Materials), Brno, Czech. Republic.
- IMT (Institute of Metals and Technologies), Ljubljana, Slovenija.
- IMTM (Institute of Materials Science and Metal) University of Technology - Mechanical Faculty, Krakow, Poland

Photovoltaic Integration in Developing Countries

ElectricHome - Assessment of Non-Electrified Houses in Southern Europe and Identification of PV System Requirements for Accelerated Large Scale Deployment of Photovoltaic Energy

This contract started on 1 January 1995 and will last for a period of 18 months. The partners are:
- Wirtschafts und Infrastruktur Planungs GmbH, München (DE), - Proposer/Contractor;
- Clean Power (GR);
- ETA (IT);
- UGC/SEMAI (ES);
- UNL/FCT (PT);
- JRC-ESTI (EC).

Following a preliminary questionnaire about the number of non-electrified houses, their typical inhabitation characteristics (seasonal/permanent) and the purpose of occupation, ESTI defined the following general PV system classes covering the different energy needs:
Class A: luxury class, target group: holiday homes
        energy configuration: 230V AC;

Class B: economy class, target group, continuously inhabited houses and settlements; energy configuration: 230V AC;

Class C: basic class, target group: cottages, periodically used buildings; energy configuration: 24V DC or 12V DC.

For each of these classes suitable electric appliances were defined. For each appliance the nominal power and the daily energy consumption were estimated. Subsequently, the appliances were separated into two groups, one for those used at a specified time of the day and the other for those with a flexible time of use. Thus, the design of a normalised daily minimum and maximum load characteristic for each class for the general sizing of components and the entire system was possible.

A paper on this project was an important contribution to the European Conference on Renewable Energy Development in Venice, 22-25 November 1995.

Other shared cost action projects won in 1995 and to be executed in 1996-98

Framework Programme Activity	Theme of FWP Activity	Subject of FWP Activity	Project Title
Research, Technological Development and Demonstration Programme	Information and Communication Technologies	Telematics Applications	• Advanced Telematics for Research in Europe
	Industrial Technologies	Industrial and Material Technologies	• Human Factors in Maintenance and Dispatch
	Environment	Environment and Climate	• Development of Innovative Techniques for Improvement of Stability of Cultural Heritage in Particular Seismic Protection • Urban Lifestyles Sustainability and Integrated Environmental Assessment • Social Processes for Environmental Valuation
	Non-Nuclear Energy		• Photovoltaic Hybrid Systems • Solar Cell Development • Advanced Module Integrated Invertex • Absolute Silicon Primary Irradiance Reference • Integrated Spatial Potential Initiative for Renewable Energy in Europe • Low Cost Monitoring Devices
Dissemination and Optimisation of Results	Dissemination and Exploitation of the Research Results	Technology Validation	• Laserobot
EURATOM Framework Programme	Nuclear Fission Safety		• Benchmark Exercise on Expert Judgement

SMART (Semi-autonomous Monitoring And Robotics Technologies)

The Human Capital and Mobility Programme SMART (Semi-autonomous Monitoring And Robotics Technologies) Research includes the JRC/ISEI, ten research laboratories and two small/medium industries from six different countries (DK, F, I, IRL, P, UK). The network aims at the development of human resources for the technologies of monitoring and surveillance, autonomous robotics and tele-operation. This objective will be achieved by having co-ordinated projects, and by transferring technological results to industry. Several post-doc fellowships are being paid by the network.
Participating laboratories:
— LIFIA - ADR, Univ. Grenoble, France (co-ordinator);
— University of Aalborg, Aalborg, Denmark;
— Robosoft SA, Paris, France;
— Trinity College of Dublin, Dublin, Ireland;
— DIST, Univ. Genoa, Genoa, Italy;
— ARTS Lab, Scuola Superiore di Sant'Anna, Pisa, Italy;
— Tecnopolis-CSata, Bari, Italy;
— Altek, Genoa, Italy;
— Instituto de Sistemas e Robótica, Lisboa, Portugal;
— University of Leeds, Leeds, United Kingdom;
— University of Reading, Reading, United Kingdom;
— University of Edinburgh, Edinburgh, United Kingdom;
— Joint Research Centre - ISEI, Ispra, Italy.

The SMART research network ended its activities in October 1995, and a proposal was submitted for its extension within the programme "Training and Mobility of Researchers". Globally, SMART provided pre-doc and post-doc fellowships for a total period of more than 200 man-months, 50% from which were used in mobility between laboratories participating in the network. Apart from the research work developed in the laboratories involved, in 1995 the network organised a workshop and co-sponsored a symposium:
— SMART Workshop on "Surveillance Systems", 27-28 April 1995, Lisbon, Portugal.
— SIRS'95, Third International Symposium on Intelligent Robotic Systems, 4-8 July 1995, Pisa, Italy.

It can be said that the network met its own objectives having organised during its lifetime three workshops, and co-sponsored three symposia. Moreover, the links established among network partners were paramount to consolidate research work, leading in some cases to consortia submitting proposals to the 4th European Framework Programme of Research and Technological Development.

Research work funded by SMART at the JRC is described under headings "Institutional Activities: Nuclear Safety and Safeguards - Mobile Robotics for the Remote Verification of Fissile Materials".

Design of Robust Human-Machine Interaction - RoHMI

Work on the RoHMI project in ISEI has focused around cognitive modelling. The objective of the work

Fig. 3.4 The method follwed for designing a cognitive model of the pilot. (Italics indicates the means used for performing the phase)

1. "Sampling knowledge engineering"
identification of relevant features of pilot's activity
CRM development

2. "Design of the cognitive model"
design of a structure synthesising the way pilots maintain situation awareness and take decisions
pen and paper

3. "Extensive knowledge engineering"
elicitation of operational knowledge & scenario elements
pilot's interviews and observations in the cockpit

4. "Prototype implementation"
software design
object oriented analysis and programming

5. "Prototype validation"
test of the plausibility of model output
joint system execution

is to provide both the theoretical basis and the computational methods for the modelling of human performance and error in the fields of interest to the Network participants. Two aspects of this work have been in progress in ISEI.

The first aspect is driven by the goal of modelling the cognitive behaviour of one particular operator: the pilot of an highly automated aircraft. Such a model should be specified enough to be implementable on a computer, and coupled with a flight simulator, in order to study human-machine interactions - for instance for a Crew Resource Management (CRM) course such as the one developed among the Aviation Safety Group (ASG).

The method followed for developing this model emphasises the integration of theoretical knowledge on cognition and the results of an activity analysis. It comes from the knowledge engineering domain and consists in 5 phases (figure 3.4). Phase 1 was performed in 1994. Most of the work of phases 2 and 3 has been performed during 1995. Nevertheless, some interviews are still needed and the final version of the model will be deliverable only when the feedback of phase 4 and 5 has been integrated.

The second aspect of the cognitive modelling work has been at the theoretical level, examining the architectural basis for a wide range of cognitive models, comparing this with the kind of errors observed in real-life complex tasks (in general), and developing an improved architectural framework for advanced cognitive modelling, with particular attention to developing successors to COSIMO /2/ There is strong synergy between this work and much work done in the RoHMI network (figure 3.5)

Work has been discussed and shared in the forum of two full RoHMI project meetings, at Delft, NL, and in Lyngby, DK, and in communication between a subgroup of the network concerned specifically with cognitive modelling. The work done in ISEI has been well represented at these meetings.

RoHMI work has been in close collaboration with
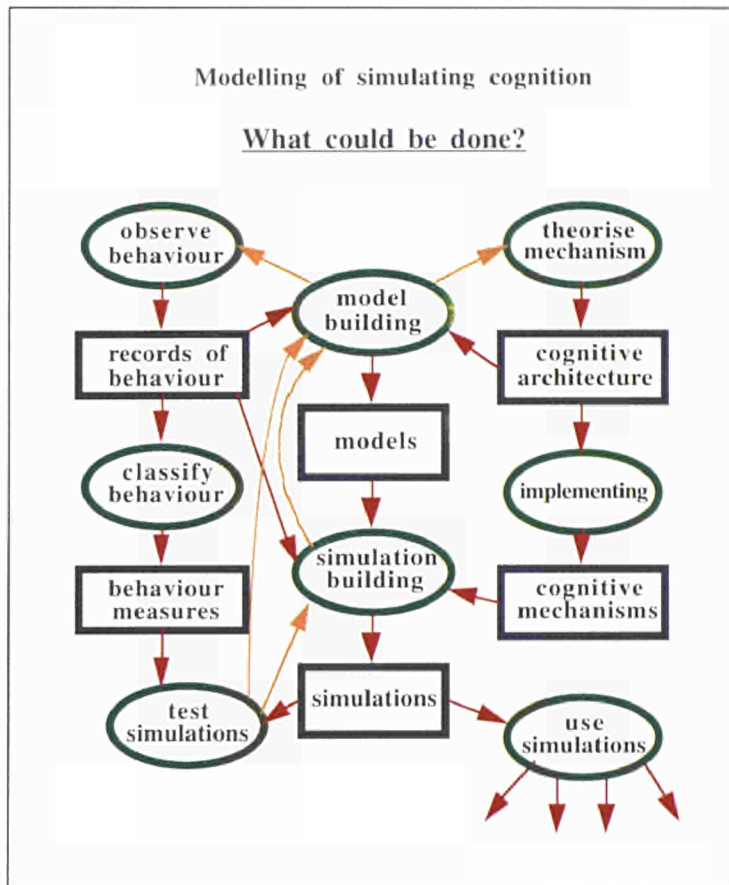
Fig. 3.5 Modelling and simulation of cognition

the Aviation Safety Group, following on from the large meeting on Aviation Safety organised in December 1994. The work contributed in a general way to a number of proposals for 4th Framework Programme funding.

Papers written have been selected for European and International conferences, and presented there/1/4/.

Other research laboratories have also been visited, both commercial and academic.

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/2/ Cacciabue P.C., Hollnagel E., (1995). Simulation of Cognition: Applications. In Hoc J.M., P.C. Cacciabue, E. Hollnagel (Eds.) *Expertise and Technology: Cognition and Human-Computer Interaction.* Lawrence Erlbaum Associates, Hillsdale, New Jersey.

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Human Factors in Complex Working Environment - HF

The research activity of this network was concluded during 1995. The focus of ISEI contribution was the development of the dynamic human reliability methodology HERMES, in conjunction with the Reactor Safety Research program. Both the prospective and retrospective uses of the human error methodology HERMES were covered. The activities developed in this area are focused on the aeronautics and aerospace domains.

After the overview of the existing taxonomies for human errors and the selection of the most promising one, a number of study cases have been performed in the civil aviation domain in order to evaluate the causes of human errors /3/.

A software tool, named DAVID (Dynamic Analysis of VIDeo), has been developed, which uses a multimedia environment, and combines the theoretical method and the field observation, i.e. the taxonomy, the model of cognition, the formal representation of events and the observations of actual occurrences like the Cockpit Voice Recorder, the Flight Data Recorder etc.

During the research activity of the network, a number of fundamental issues and other complex working environments have been considered. In particular, the decisions and communications in the Air Traffic Control have been studied by simulation approaches and by field studies /1/2/.

The combination of this activity with a contractual development performed for the Italian National Council of Research has lead to the implementation of the simulator of a control station with "two working positions" dedicated to a laboratory experiment. The simulation of the air-space and of the human-machine interfaces have been derived from existing tools already developed by other partners in the network /4/.

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/2 /Hollnagel E., Cacciabue P.C., Hoc J.M., (1995). Work with Technology: some Fundamental Issues. In Hoc J.M., P.C. Cacciabue, E. Hollnagel (Eds.) *Expertise and Technology: Cognition and Human-Computer Interaction.* Lawrence Erlbaum Associates, Hillsdale, New Jersey.

/3 /Pedrali M., Cojazzi, G., Cacciabue P.C., (1995). A Methodology for Prospective Analyses of Accidents Involving Human Errors, 8th International Symposium on Aviation Psychology, Columbus, Ohio, 23-27 April, 1995

/4/ Vanderhaegen, F. (1995). Mise en œuvre d'une plate-forme expérimentale pour la simulation du contrôle du trafic aérien d'approche. *Final report. - Research contract 10639-94-12F1 ED ISP F, Joint Research Centre*, Institute for Systems Engineering and Informatics.

Human Factors and Human-Machine Interaction Studies

The Human Error Reliability Methodology for Event Sequences (HERMES) has been further developed in conduction with the corresponding activity performed in the Reactor Safety programme. HERMES has been applied to the study of a pilot aeroplane interaction. The analysis took into account the approach to landing phase focusing on two types of human errors performed by the pilot or by the co-pilot, namely omission and commission errors. The results obtained by applying HERMES are compared with those obtained performing a "classical" human reliability study for the same case. The advantages and the potential applications of HERMES are enhanced by the comparison and by a number of parametric studies /1/.

A Root Cause Analysis study has been performed on two aeronautical accidents. They involved respectively an A320, approaching the Strasbourg airport in January 1992, and a DC9-30, approaching the Zurich airport in November 1990. The results of the analyses show a number of similarities in the two accidents. Despite the technological differences between the two aeroplanes, external causes tied to procedures or interfaces can trigger the same person related causes. This leaves a number of open issues that can be further analysed, such as the problems of co-operation and communication within and outside the cockpit /2/.

A study of the Traffic Collision Avoidance System (TCAS) has been conducted /3/4/. The traffic collision avoidance system TCAS is the latest introduced among the pilot support systems. Depending on the employed TCAS type, the system is able to notify hazardous traffic conditions as well as to suggest escaping manoeuvres to the pilot. The main features of TCAS have been investigated, in order to develop two different system models: one based on the actual logic implemented in the real system, and a new one based on fuzzy logic. Both models have been integrated in a simulation environment, particularly suitable to human-machine studies. A number of test cases, based on real situations, have been designed and performed to study the TCAS effect in the approach to landing phase. Even if a very simple fuzzy model has been considered, the two models have exhibited a comparable behaviour, showing the applicability of fuzzy logic to TCAS. Figure 3.6 /3/ presents the definition of the input and output fuzzy sets for the fuzzy controller implementing the TCAS logic used to emit an advisory message, employing to this aim, a crisp output variable.

References

/1/ Cacciabue P.C., Cojazzi G., (1995), An Integrated Simulation approach for the Analysis of Pilot-Aeroplane Interaction, Control Eng. Practice, Vol. 3, No 2, pp 257-266, ISEI/IE 2816/95.

/2/ Pedrali M., Cojazzi G., Cacciabue P.C., (1995), A Methodology for Retrospective Analyses of Accidents Involving Human Factors, Proc. The Eight International Symposium on Aviation Psychology, April 24-27, 1995, Columbus, Ohio USA, ISEI/IE 2869/95.

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/4/ Cardani C., Cojazzi G., Saccuman P., (1995), Valutazione dell' efficacia di un sistema TCAS e proposta di un algoritmo alternativo basato sulla logica fuzzy, XIII Congresso Nazionale, AIDAA, Associazione Italiana di Aeronautica e Astronautica, Roma, Italy, September 11-15 1995, ISEI/IE 3027/95.
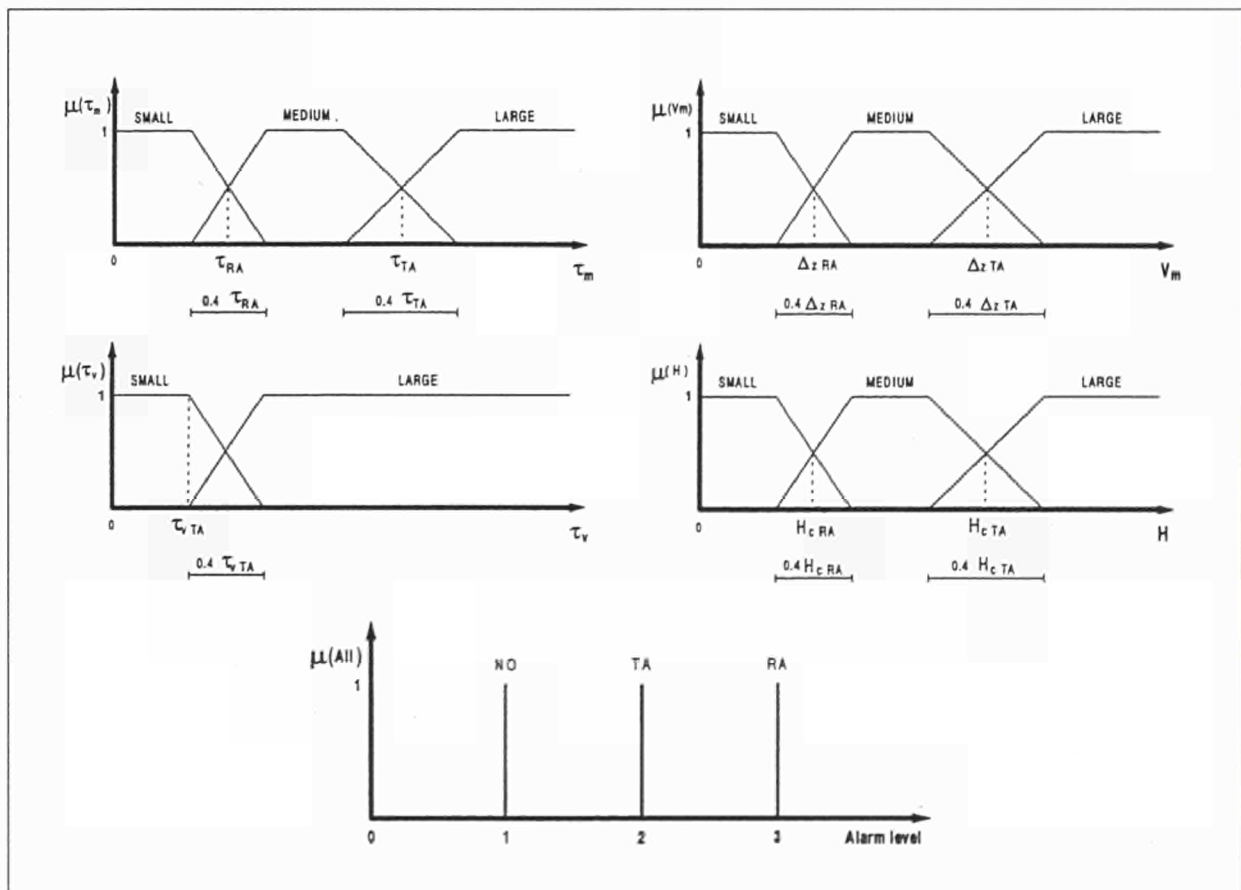
Fig. 3.6 Definition of the input and output fuzzy sets of the fuzzy controller implementing TCAS logic for the emission of advisory messages.

Diagnostics and Reliability of Composite Materials and Structures for Advanced Trasportation Applications

Partners

- Département Mécanique et Matériaux, Ecole Nationale Supérieure des Mines de Saint-Etienne, France, (coordinator: Prof. Alain Vautrin).
- Institut Supérieur de l'Automobile et des Transports, Nevers France.
- Università di Napoli, Dip. Ingegneria Materiali e Produzione, Italy.
- Hellenic Aerospace Industry Ltd, Research and Development, Athens Greece.
- Dept.of Eng. Science, Section of Mechanics, National Technical University of Athens, Greece.
- Dept. of Metallurgy and Materials Engineering, Katholieke Universiteit Leuven, Belgium.
- Instituto de Engenharia Mecânica, Polo I.S.T., Lisbon Portugal.
- Instituto de Engenharia Mecânica e Gestão Industrial, Porto Portugal.
- Institute for Systems Engineering and Informatics, JRC-Ispra.

The objectives are the implementation and comparison of various scientific approaches in order to establish unified procedures and tests for the assessment of the reliability of these materials and structures.

JRC/ISEI is contributing to the non-destructive evaluation by laser interferometric methods, and acoustic and thermal emission. Typical structures chosen were sandwich panels with skins of composite material (thermosetting-carbon) and hexagonal cell honeycomb core. A post-doctoral fellow has been hosted at the JRC labs for eight months Dec.93-July94.

The work so far has involved mechanical tensile tests on unidirectional $[0]_8$, $[90]_8$, $[90]_{16}$ and multidirectional laminates $[90, 0, 90, 0]_{2S}$ and $[±45, 0, 90]_{2S}$. It has focused on the utilisation of acoustic and thermal emission for the determination of a hypothetical 'yielding point' in composite materials. It is based on the analogy between the dissipative phenomena appearing during the two emission processes, and manifests itself with the so-called "knee behaviour". The duration of this network activity has been extended by the Commission for one more year (until 31 Oct. 1997).
A particularly fruitful synergism took place among the activities performed in the frame of the mentioned Network and the ones carried out, in the field of application of acoustic emission techniques on new materials, by HC&M post doc grant holders performing their research activities in ISEI laboratories. The results of their work are briefly summarised hereafter.

Adhesive bond quality assessment by Acoustic Emission

The main objective of this work has been the development of a real-time control system during the cure cycle of adhesive joints and of a proposal, if reasonable, of an alternative bonding procedure that could allow a possible reduction of costs due to the modification of the critical parameters (time, temperature and pressure) while maintaining the same quality standards.

The materials employed to produce the joints were aluminium alloy (2024T3) laminae connected by a modified epoxy adhesive. A large number of tests, monitored by acoustic emission, were thus effected, aiming first to produce an ideal-procedure joint to be compared with other modified procedures joints.

The experiments included simulation of defects inside the joints (Teflon interposition, lack of superficial anodising layer on aluminium alloy) as well as the variation of the cure cycle (temperature, time or pressure).

A semi-quantitative measure of the enthalpies involved during polymerisation and the behaviour of the adhesive at different temperatures were also performed using Digital Scanning Calorimetry. The shear strength of the joints was finally assessed by destructive tensile testing. Collaborators at this project were CIRA (Italian Centre of Aerospace Research), Politecnico di Milano-Aeronautics Dept. and AGUSTA.

Activities on ceramics

A study on fracture behaviour during catastrophic failure (4-points bending tests: 15 sec. to failure) of yttria partially stabilised (PSZ) zirconia was effected with acoustic emission monitoring and statistical tools, in order to obtain an estimation of the degree of brittleness shown by different samples and of the dispersion of mechanical data.
This work, in the frame of a Round Robin testing exercise among twelve different laboratories, was effected together with the Università di Roma which supplied the material and also performed fractography and EDAX microanalysis.

A feasibility study was carried out to evaluate the possibility of a quality discrimination by means of acoustic emission on WC-Co tips coated with a TiN and CN layers (PVD technique) to be used on cutting tools. The initial goal was to discern the differences in acoustic activity passing from an integer layer tip to a damaged one.

References

/1/ Marini, R. and Solomos, G., "Composites Strength Determination via Acoustic and Thermal Emission", Tech. Note No.I.95.17, ISEI/IE/28601/95, JRC-Ispra, Feb. 1995.

/2/ Marini, R. and Solomos, G., "Design Strength Determination of CFRP by Acoustic Emission Testing", Proceedings COMP '95 Symposium: High Technology Composites in Modern Applications, 18-22 Sept., 1995, Corfu, Greece.

/3/ Santulli, C., Solomos, G., Calabro, A., Caneva, C., D'Antonio, L., "AE monitoring during cure cycle of metal/metal (2024 T3 alloy) adhesive joints for quality control", Proceedings 5th International Symposium on Acoustic Emission from Composite Materials (AECM-5),10-14 July, 1995, Sundsvall Sweden.

/4/ Santulli, C., Solomos, G., Calabro, A., Caneva, C., D'Antonio, L., "AE monitoring during cure cycle of metal/metal (2024 T3 alloy) adhesive joints for quality control", Proceedings 5th International Symposium on Acoustic Emission from Composite Materials (AECM-5),10-14 July, 1995, Sundsvall Sweden.

/5/ M.Tatti, C.Santulli, "Sensore in Fibra Ottica per l'Acquisizione di Segnali di Emissione Acustica", 8°Congresso Nazionale dell'AIPnD, Torino, 17-19 Ottobre 1995

/6/ D.Sangalli, C.Santulli et al., "Analysis of Manufacturing Problems Related with Metal-Metal Aerospace Structural Joints Through Acoustic Emission and Differential Scanning Calorimetry", 22nd European Conference on Acoustic Emission Testing, Aberdeen, 29-31 May 1995

/7/ F.Billi, C.Santulli, "A Study on the Mechanical Behaviour of PSZ (5% wt yttria) During Bending Tests Comparing Weibull Statistical Model and Acoustic Emission Results", 6th Int. Symposium on Fracture Mechanics of Ceramics, Karlsruhe, 18-20 July 1995

/8/ F.Billi, C.Santulli, "Correlation Between Fracture Mechanics and Acoustic Emission Detected During Bending Tests on Ceramic Material by Means of Statistical Methods", 10th Int. Symposium "Progress in Metal and New Material Investigation Methods", Saint Etienne 15-16 November 1995

Reability of Metal Matrix Composites

Partners:

- Lab. Chimie du Solide, CNRS, Bordeaux, France, (coordinator: Prof. M.Onillon);
- Université C. Bernard, Lyon, France;
- Inst. Nat. Sciences Appliquees, Lyon, France;
- Nat. Tech. University of Athens, Greece;
- Univ. La Sapienza di Roma, Italy;
- LNETI, Lisbon, Portugal;
- INEGI, Univ. do Porto, Portugal;
- ZFW, Univ. of Clausthal, Germany;
- Univ. of Reading, U.K;
- Hi-Tec Metals R&D, Southampton, U.K.;
- Institute for Systems Engineering and Informatics, JRC-Ispra.

The objective is to study the several aspects of MMC (manufacturing, characterisation, modelling...), which can lead to the industrial adoption and reliable use of these materials.

ISEI contributes to the development and validation of suitable mechanical measurement techniques aiming at:
- providing mechanical properties data for use in the engineering design;
- assessing the integrity of MMC components by non destructive methods.

Given the limited resources, a post-doctoral fellow has been hosted for six months, Aug.94-Jan.95, and a state-of-the-art report on mechanical testing and NDT of MMC has been produced.

Along this activity, compression and tensile tests with acoustic emission (AE) monitoring were carried out on Al_2O_3 fibre reinforced 2014T6 and Al_2O_3 particle reinforced 6061T4 and 6061T6 aluminium alloys. Fractographic analysis was performed on some failed specimens.

The goal of this research was to find out correlation trends between AE results, fracture-behaviour and stress-strain curves. The work was performed in collaboration with the Politecnico di Milano - Mechanics Dept., which supplied the material and the Scanning Electron Microscope for fractography.

References

/1/ Marini, R., "Metal Matrix Composites - The State of the Art", Tech. Note No.I.95.16, ISEI/IE/2858/95, JRC-Ispra, Feb. 1995.

/2/ E.Gariboldi, C.Santulli, F.Stivali, M.Vedani, "Valutazione del danneggiamento in materiali compositi a matrice metallica tramite monitoraggio di emissione acustica", XI Convegno Nazionale IGF, Brescia, 4-6 luglio 1995.

OLOS - A Holostic Approach to the Dependability Analysis and Evaluation of Control Systems Involving Hardware, Software and Human Resources

Partners:

- ENEA, Roma (I);
- CSR, City University, London (UK);
- Vrij Universiteit, Amsterdam (NL);
- LAAS-CNRS, Toulouse (F);
- Texas A&M University, (USA);
- Universita di Siena (I);
- IEI-CNR, Pisa (I);
- Adelard, London (UK);
- LFCS, University of Edinburgh (UK);
- Universita di Roma "Tor Vergata", Roma (I);
- Computer Resources International, Copenhagen (DK)
- JRC-ISEI (CEC).

OLOS proposes a significant innovation in the dependability analysis and evaluation of safety-critical systems. Instead of regarding the human, hardware and software components as effectively independent, OLOS takes a holistic view which seeks to identify the component inter-dependencies and incorporate the evaluation of these aspects within a common framework. The objectives of OLOS are a) to develop interdisciplinary competencies, especially among young researchers, concerning "global system dependability"; b) to define and develop the concept of "global system dependability" in order that various dependability and reliability notions and methodologies can be seen to make a contribution to overall dependability; c) to promote the development of an integrated set of methodologies to be used for the dependability analysis and evaluation of those critical systems that require the combination of hardware, software and human resources.

3.4 THIRD PARTY WORK

Behaviour of Multipage Transponder Cards

The third party work was conducted for Texas Instruments (Germany) in order to qualify the behaviour of a number of Multipage Transponder Cards (see Figure 3.7.) when submitted to mechanical sinus vibrations and also to drop tests. These tests were conducted in TEMPEST (Thermal, ElectroMagnetic & Physical Equipment Stress Testing) laboratory under customer's specifications. The final test report was sent to the customer in November 1995.
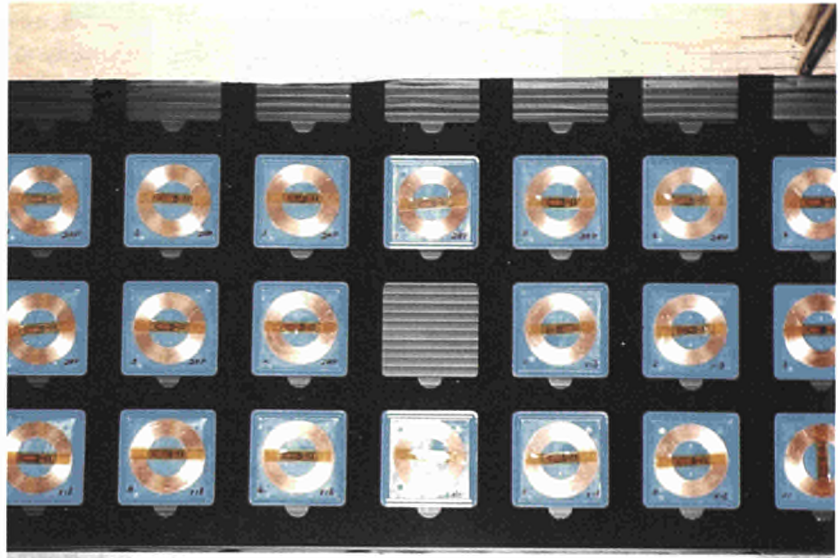
Fig. 3.7 View of 20 Multipage Transponder Cards

Contract with PNC, Japan

A contract with the Japanese company PNC for the development of a special sealing system for PNC owned COGEMA PuO_2 containers (FS-47) has been completed successfully. A brand new "Clamping Seal" system has been developed and all planned tests and demonstration could be carried out satisfactorily in Ispra and Tokai (J) (figure 3.8) /1/2/. Also a transportation demonstration was successfully organised from Cadarache (F) to La Hague (F) with the support of the French COGEMA company (Figures 3.9, 3.10). The portable reading equipment was used systematically and has proven to be safe, accurate and handy while used in different actual circumstances.

The production of a series of special "Clamping Seals" was completed.

References:

/1/ B.C. d'Agraives, (SILab JRC-Ispra) Intermediate Technical Report (Aug. 1993/May 1995), Contract PNC/JRC 5169-93-01 TG ISP J, Ispra, June-July 1995

/2/ B.C. d'Agraives, J. Toornvliet, P. Tebaldi, E. Mascetti, (SILab JRC-Ispra); B. Silber, (RMT, G); T. Hayakawa, T. Hosoma, J. Kurakami, M. Akiba, (PNC Japan). First Tests with a New Portable Ultrasonic Sealing System for PuO2 Transport Containers, INMM 36th Annual Meeting, Palm Desert, 9-12 July 1995
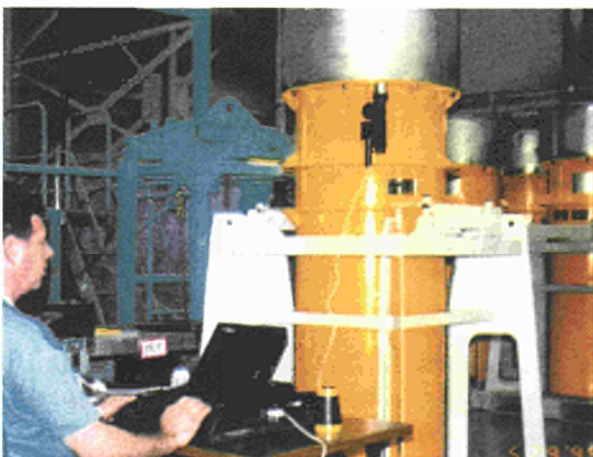
Fig. 3.8 Demonstration of a MK5-CI seal on a FS-47 in Tokai (J)

Fig. 3.9 Preparation of a transport test with on FS-47 casks from COGEMA facility in Cadarache (F)

Genetically Modified Micro-Organisms

A study was initiated that aims at the development of methods and methodologies to assess the risk associated with contained use facilities for genetically modified micro-organisms. The study is carried out on behalf of ISPESL, the Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro (Italian Ministry for Prevention and Safety at Work).

Crew Resource Management

Approximately 70% of all aircraft accidents and incidents have human factors as their primary cause and one of the most powerful means to ameliorate non-technical aspects of flight safety has proven to be awareness-creating training courses. These statistics prompted the Crew Resource Management (CRM) project. It is a course training dedicated to develop an understanding and awareness of the Human Factor problems amongst airline pilots /2/.

The focus of the project was the development of an innovative CRM training, using as a basis for the training development a profound analysis of the organisation and the safety attitudes of the airline pilots. The training utilises an advanced computer-based multi-media system in specific training sessions. The airline instructors received training in special CRM facilitation techniques, enabling them to give the CRM training in an efficient and adequate manner. The CRM-JRC for a small charter operator has been completed and currently being commercially exploited for the national Italian operator, Alitalia.

The CRM project focuses on 4 main objectives: Analysis of Airline; Facilitators Skills Training; Computer Based Training; Human Factors Seminar.
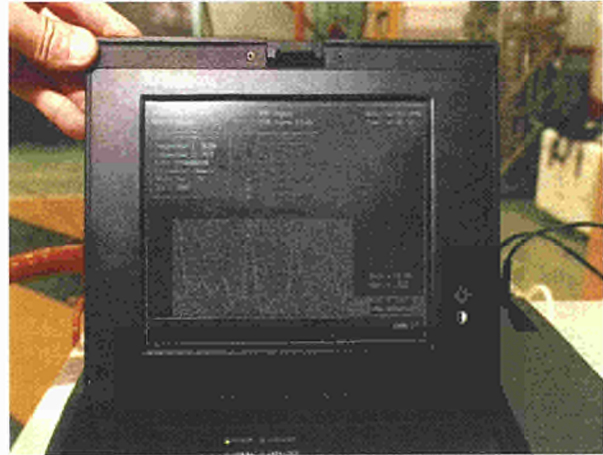
Fig. 3.10 Typical verification measurement obtained with a MK5-CI seal in Cadarache

In particular, the Computer Based Training (CBT) is the pre-course material, self-paced and based on advanced multi-media technology using video/audio, integrated with user controlled interaction. The CBT sessions are centred around aircraft accident case studies and represent an introduction to help the pilots reflect upon the work, working conditions and limitations of humans, not only in generic terms, but also for the participant him- or herself. In Figure 3.11 a typical "flight path
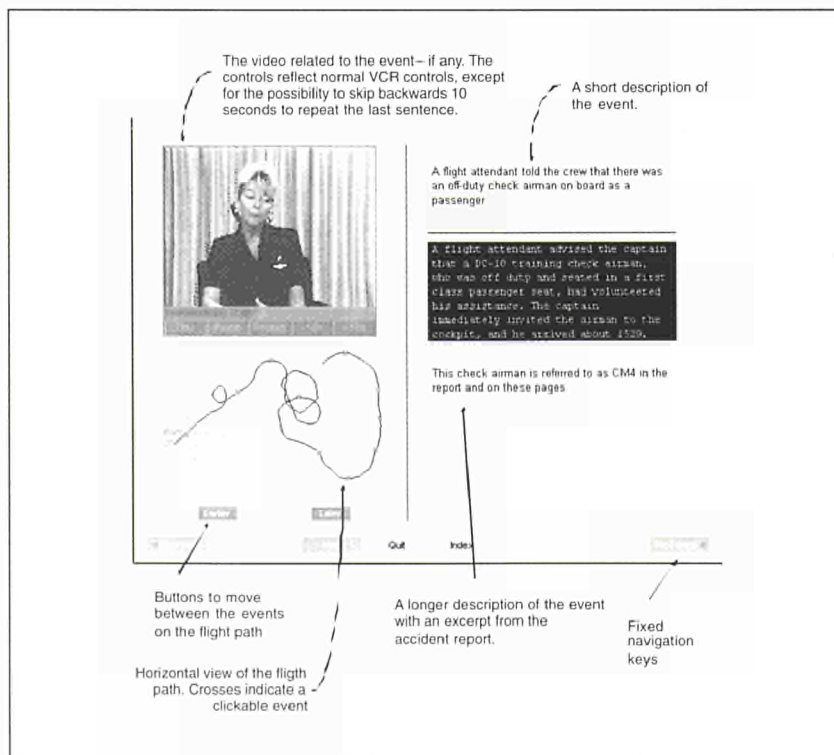
Fig. 3.11 Typical "flight path page" of the Computer Based Training (CBT).

page" is shown. It gives the user a view of the flight path during the accident sequence together with accident report excerpts and video clips for relevant points on the flight path. The flight path page shows in the lower left corner the flight path of the plane from the initial event to the landing or crash. The events discussed in the presentation are marked with crosses, and for each of these events there is a short description in the upper right corner and below, a longer description with an excerpt from the accident report. In the upper left corner is seen the video clip if there is one. The pilots are exposed to a session of CBT describing real accidents and can examine the sequences of events and the Human Factors involvement as many time as they wish and for as long as necessary. A written text and a questionnaire are used to help in the use of the multimedia training tool.

References:

/1/ Kjær-Hansen, J. (1995). Strategy and Method for Human Factors Training: The JRC-CRM Experience. *Proceedings of Eighth Symposium on Aviation Psychology*. Columbus, Ohio, April 24 - 27, 1995.

/2/ Lie, A. M., Kjær-Hansen, J. & Gagliardi, A. (1995). Safety culture in an airline. *Proceedings of Eighth Symposium on Aviation Psychology*. Columbus, Ohio, April 24 - 27, 1995.

Air Traffic Control (ATC)

In collaboration with the Italian National Council of Research (CNR) for the FATMA project (Prevenzione e Controllo dei Fattori di Malattia) work in the field of Air Traffic Control (ATC) has been in progress for the last three years. The activity in ATC deals with the study of the effects of stress on humans and machines in complex organisation. The objective is fourfold:
— to analyse the causes and the consequences of stress on task management, co-operation and communication;
— to model the relationship between stress, co-operation and communication;
— to develop requirements and specifications for the design of the interfaces of ATC systems in co-operative work;
— to use the results for human factors training.

This activity has been performed by reading manuals and procedures, by interviewing experts from the domain and by a field study. The field study has been carried out in three main phases data collection by video recording the ATCOs (Air Traffic Control

Operators) in the field; data transcription of the communications in McSHAPA /1/, a tool for analysing verbal protocols and data analysis focused on the identification of the task-related factors of stress and how these factors have an impact on communication and co-operation between ATCOs. The co-operation between different ATCOs, and the interaction between ATCOs and computers, is studied through the analysis of the communication flow between the ATCOs working at different working positions. A similar pattern with different ATCOs has been identified during the management of stressful situations such as the management of conflicts.

An experimental platform has been developed, organised for a simulation of two radar controllers' working positions. It has been designed as two bidisplay X terminals which allow the management of two screens with one keyboard and a mouse, and a Sun station SOLARIS 2 to facilitate processing of time-consuming modules of a simulator software, called MASS (Multiple Aircraft Simplified Simulator). The experimental design is for two controllers managing a given sector according to predefined realistic scenarios. This kind of experiment can be used to test the management of incidents such as conflicts for training, and to provide an analytical tool to answer questions about human/automation interaction in ATC and ATM (Air Traffic Management), as well as to predict performance errors /2/3/.

References:

/1/ Sanderson, P.M. (1995), MacSHAPA manual: version 1.0.2. Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign, Urbana, Il, USA.

/2/ Bellorini, A., Vanderhaegen, F. (1995). Communication and cooperation in Air Traffic Control. *Eighth International Symposium on Aviation Psychology*, April 24th-27th 1995, Columbus, Ohio, U.S.A.

/3/ Vanderhaegen, F., (1995). Human-machine organization study: the case of the air traffic control. *6th IFAC/IFIP/IFORS/ IEA Symposium on Analysis, Design and Evaluation of Man-Machine Systems*. 27th-29th June, Massachusetts Institute of Technology, Cambridge, USA.

Quantitative Casual Tree in Aviation Safety

The JRC/ISEI has executed a contract for the Dutch National Space Laboratory (NLR) on the Conceptual Issues and Statistical Data Requirements for the Use of Quantitative Causal Trees (QCT) in Aviation Safety.

The main conclusions and recommendations of the contract can be summarised as follows. The use of QCT, or a risk analysis approach, for studying and analysing safety is one of the most widely used methodologies amongst the practitioners of modern technology. These techniques have been studied and refined over 20 years of research and application and are certainly widely applied by the industrial domain. This implies that a QCT approach can be used also in the aeronautical domain. In particular, the nuclear, the chemical and the process industry, make very extensive use of these approaches for improving the knowledge about their systems, for demonstrating safety levels, and for evaluating the risk associated with possible accident/incident configurations.

Moreover it is of enormous importance for the attitude of the safety and regulatory bodies in some member countries, which demand the development of risk studies and of risk management approaches for the licensing of plants and systems.
These requirements stem also from specific norms and Directives from the EU that require the implementation of risk methods for the safety cases of chemical (Seveso directive) and in all workplaces (Directive 365 of 1992). These requirements will be included also in the aeronautical domain in future directives of the EU.

However, advantage should be taken of the major problems that the application of these methods have shown in the many years of application in other industries. These problems have been well identified in the final report and, in particular, have been precisely spelled out in all the workpackages. They can be summarised briefly in:
— The unavailability of data, or better the existence of data with very large uncertainties have to be included in the risk study. This leads to greater uncertainties on the consequences. In particular, in the case of expert judgement the problem is even more acute.
— The intrinsic dynamic behaviour of systems requires the use of more advanced methods that are being proposed in the literature and could be a way forward for research.
— The real important and crucial issue of Human Factors, which contains the whole of the above two problems, i.e. data and dynamic aspects, and even more. Here also methods are being proposed and they need to be further studied and developed /1/.

Reference:

/1/ Cacciabue P.C., Cojazzi G., (1995). An integrated simulation approach for the anlysis of pilot-aeroplane interaction. *Control Engineering Practice*, 3, 2, pp.257-266.

Human Factors Data Collection and Taxonomy

Two study contracts on Human Factors data collection and taxonomies have been executed for the Italian Institute for Safety at Work (ISPESL). They focused on:
— the use and applicability of Human Factors methods and classifications for root cause analysis of accidents and incidents at work;
— the feasibility study for the development of classifications schemes dedicated to indexing environmental impact, accident risk and human-environment interaction /1/.

The main conclusions of the first contract describe a selection of classifications of human errors, or taxonomies, relevant in the context of the analysis of human machine interaction. For the analysis of human machine interaction, a systematic taxonomy for error classification is necessary in order to clearly distinguish between internal and external causes affecting human behaviour, between causes and effects and between causes and manifestation of behaviour. Moreover, from a methodological point of view, the analysis of human (erroneous) behaviour should be based on two steps of theoretical nature: a model or paradigm of human behaviour; a taxonomy for human erroneous behaviour based on the selected paradigm. In this contract the analysis focused on the latter step.

The main conclusion of the second contract concerned a plan of development of a thesaurus of indexing related to the International Occupational Safety and Health Information Centre, specifically to the Human Environment interaction.

Reference:

/1/ Cacciabue, P.C., Olivi, L., Parisi, P., (1995). Modalità di indicizzazione di documentazione attinente tematiche di impatto ambientale, rischio di incidente rilevante, interazione uomo macchina ambiente. TN. I.95.105.

Support to Regional Development: Sicily Projects

Main data

Two Conventions, respectively between Regione Siciliana and JRC, and Regione Siciliana and the Universities of Catania, Messina and Palermo, were signed on April 27, 1994, by the Director General of the JRC, the President of the Regione Siciliana and the Rectors of the Sicilian Universities /1/. These Conventions have become operative, after the approval by the Sicilian Consiglio di Giustizia Amministrativa and the Sicilian Corte dei Conti, on December 14, 1994. The duration of the Convention is 24 months: the activities shall end by the end of 1996.

JRC activities are directly supported by regional funds, while the Universities are funded by EC Structural Funds, Objective 1. The overall budget is of about 23 Mecu, 6.5 on which are for JRC work.

The Convention contains six Projects /2/:
Project A: *Management of water resources*
Participating Institutes: IE, IRSA, ISEI.
Project B: *Air pollution in industrial and urban centres*
Participating Institutes: IE, ISEI.
Project C: *Pollution and erosion of soil*
Participating Institutes: IE, IRSA, ISEI.
Project D: *Safety and reliability of chemical and petrochemical installations*
Participating Institutes: ISEI, IST
Project E: *Cultural heritage*
Participating Institutes: ISEI, IST
Project F: *Reference values of trace elements in inhabitants of Sicily Region*
Participating Institutes: IRSA.

A brief description of the objectives of each Project and of the results obtained in the course of 1995 (first year of activity) is given in the following chapters, while more detailed information is given in the annual reports of the participating laboratories.

General Management and Overall Executive Summary of Results

The President of the Sicily Region is the customer of the work. He acts through the Department for Regional Planning. The actuators of the Convention are the Joint Research Centre of the European Commission,

the Study University of Catania, the Study University of Messina and the Study University of Palermo.

A steering committee (named *Technical and Scientific Committee*) has been set up by the President of Sicily Region for monitoring, controlling and evaluating the work performed. Biannual Progress Reports are due to the President of Sicily Region.

The four actuators have set up similar working structures based on the subdivision of the projects in Modules, each under the responsibility of a Task Leader. Four levels of jobs have been organised:
– the Project Owner
– the Project Manager
– six Project Leaders
– the Task Leaders (responsible of Modules).

The total of the six projects contains 163 Modules, entailing the contribution of some 73 different Institutes or Departments.

A Project Manual (reported in /3/, Vol.3 and /4/, Vol.2) has been prepared by JRC Project Manager, containing the definition of working structure, work breakdown structure, responsibility distribution, procedures for monitoring and evaluation (scientific, administrative and financial), document registration and archiving, characteristics and formats of reports, figures, documents etc. Each project Leader has then prepared a Planning Manual for his Project, containing relevant planning, work breakdown structure, Gannt chart, milestones, deliverables, Modules clustering, Modules interaction, etc. (can be found in /3/, Vol.3 and /4/, Vol.2).

The activity of the first 12 months has been characterised by an ever increasing degree of collaboration and exchanges between JRC and Sicily Universities, leading to the organisation, in the beginning of 1996, of several topical meetings, in Sicily. The use of allocated resources has been in agreement with planning and, what matters most to everybody, the planned milestones and results have been achieved. From the point of view of interaction with Regional Administration and technology transfer, JRC is pushing to:
– have tighter contacts and interaction with technical people of the regional councillorship ship relevant to each Project;
– identify the final receiver of our technical deliverables and define a strategy for future updating and maintenance;

– give a more official and formalised structure to the ongoing technology transfer.
– define the results dissemination policy

Two General Meetings have been held in 1995: Palermo, May 29-30-31 and Messina, November 27-28-29, during which the content of the first and second Biannual Progress Report has been presented and discussed by JRC and Universities /3/4/.

Project A: Management of Water Resources

Subprojects:

1. "Research for the identification of criteria and methodologies for managing water resources", containing 14 Work Packages (Modules), performed by the University of Catania (4), University of Messina (1), University of Palermo (7) and JRC (2).
2. "Research for assessing the possibility of monitoring water quality and quantity", containing 10 Work Packages (Modules), performed by the University of Catania (3), University of Messina (2), University of Palermo (4) and JRC (1).
3. "Analysis of the consequences, on the costal echosystem, of the use of water resources", containing 9 Work Packages (Modules), performed by the University of Catania (3), University of Messina (1), University of Palermo (4) and JRC (1).
4. "Development of a Decision Support System for management of water resources", containing 9 Work Packages (Modules), performed by the University of Catania (2) and JRC (7).

Main Results

A Data Base has been prepared and linked to Internet. It contains the first results of the study of water quality. As far as the evaluation of marine environment (coastal area) is concerned:
– on the regional scale, a data set has been created with Sicily images from satellite, integrated into a GIS (Geographic Information System);
– on the local scale, the identification of environmental indicators for coastal ecosystem :lassification is under way.
A Demo version of the relevant Decision Support System has been implemented for local as well as remote use (World Wide Web). A Distributed Information System is under development; to this end, a Gateway has been realised for the GIS (Arc-Info)

and for Oracle Database; the analysis of the methodologies for introduction in web of information coming from specific Databases and Excel Spreadsheets, performed; hypertext documents for GIS, prepared: among them, one document dealing with the criteria for the identification of sensitive areas and one with the quality of surface water.

The type of general information to be inserted in the Geographic Information System and made available through the a Distributed Information System, has been jointly defined by JRC and the Sicilian Universities.

Quite an important activity has been devoted to acquisition and structuring of information on the two selected study cases, namely:
– Study case N.1   river Anapo basin
– Study case N.2   river Poma and lato basin

The methodological development based on satellite data is being made for the Simeto river basin (in strong synergism with Project C on Pollution and erosion of soil), while the application on Anapo case is foreseen.

For the Anapo case, the activity was focused on the identification of evaluation criteria, admissible alternatives and interest groups, in order to single out the possible conflictual interests and their effect on the use of land resources. For the second case, dealing with drinking water supply to Palermo city, data acquisition has been started by digitisation of 1:50 000 scale maps supplied by IGMI (Italian Military Geographic Institute).

Project B: Air-Pollution in Industrial and Urban Centres

Subprojects:

1. Messina city; containing 10 Work Packages (Modules), University of Messina (4) and JRC (6);
2. Industrial area of Milazzo, containing 6 Work Packages (Modules), University of Messina (4) and JRC (2);
3. Catania city, containing 15 Work Packages (Modules), performed by the University University of Messina (4) and JRC (2);
4. Palermo city, containing 9 Work Packages (Modules), performed by the University of Palermo (6) and JRC (3).

Main Results

The winter and summer campaigns for the measurement on NO_2 level in Catania, Messina and Palermo have been completed. A total of about 300 sensors (diffusion tubes) were installed in properly selected locations of the three cities; twelve times the sensors were removed (six times during the winter campaign and six times during the summer one) for measurement and replaced by virgin sensors (exposure time = 15 days). The NO_2 concentration maps are now being produced and data analysis going on.

The original technical programme envisaged the measurement of SO_2 level in Catania as well, but it is now world-wide recognised that SO_2 levels are decreasing almost everywhere and that it would be more useful to monitor the concentration of volatile organic compounds, namely benzene, toluene and xylene (BTX). They in fact seem to be precursor agents in the formation of ozone and to be carcinogenic substances. For this reason a proposal has been submitted to the Technical and Scientific Committee for substituting the SO_2 measurement by BTX measurements.

Project C: Pollution and Erosion of Soil

Subprojects:

1. Estimation and control of soil erosion, containing 9 Work Packages (Modules), performed by the University of Catania (2), University of Palermo (6) and JRC (1);
2. Management of sediments, containing 2 Work Packages (Modules), performed by the University of Catania (1) and JRC (1);
3. Soil pollution due to the use of refluent water for irrigation, containing 2 Work Packages (Modules), performed by the University of Catania (1) and JRC (1);
4. Soil pollution due to solid waste disposal, containing 5 Work Packages (Modules), performed by the University of Messina (1), University of Palermo (2) and JRC (2).

Main results

For the subprojects devoted to soil erosion and sediments, two study area have been selected:
– river Timeto catchment basin (100 km²)
– river Simeto catchment basin (4 300 km²)

and a large activity performed for the acquisition and storage of data: digital conversion of Sicilian soil maps and hydrographic map; collection of daily rainfall and temperature data for the period 1960-1988; acquisition of Lansat-TM images whose time sequence allows to obtain information on vegetation growth; etc. Beside the data collection activity:
– the digital terrain models of the study areas have been developed;
– two measurement campaigns have been performed in July and November;
– preliminary classifications of soil covering for Timeto and Simeto basins have been produced.

In the frame of the subprojects dealing with pollution problems, the set up of a mobile unit for the identification of organic and inorganic pollutants in soil and water has been completed, as well as the analysis for the characterisation of soil and water samples taken by University of Catania.

A measurement campaign has been planned on the garbage dump of Lipari (Eolie Islands), chosen for its touristic importance: The aim of the campaign is the customised validation of the methodology for identification of toxic or harmful products.

For the development of a dedicated Decision Support System for managing, at regional scale, urban and industrial waste collection, the work done so far can be summarised as follows:
– data on urban waste on Trapani and Palermo provinces collected (to be used for the test case);
– system architecture designed and relevant informatic code developed;
– NAIADE model chosen as the multicriteria decision model;
– data and information collected on: classification of industrial waste, analysis of the location where waste is produced and accumulated, analysis of waste transport system and of possible locations of waste treatment plants.

Project D: Safety and Reliability of Chemical and Petrochemical Installations

Subprojects:

1. Identification of risk and accident sequences, containing 4 Work Packages (Modules), performed by the University of Palermo (3) and JRC (1);

2. Prevention and mitigation, containing 11 Work Packages (Modules), performed by the University of Catania (5), University of Messina (1), University of Palermo (1) and JRC (4);
3. Estimation of consequences, containing 4 Work Packages (Modules), performed by the University of Catania (1), University of Palermo (1) and JRC (2);
4. Risk analysis, containing 5 Work Packages (Modules), performed by the University of Catania (2), University of Messina (1), University of Palermo (1) and JRC (1).

Main results

This project is certainly characterised by the many topics dealt with and by the many competencies involved. This required a special initial effort in order to organise and plan properly the activities, but at this mid-point of the project substantial progress has already been made.

For the Modules dealing with identification of risk and accident sequences, the MARS database (Major Accident Reporting System) has been modified and transferred to Sicilian partners, as well as the software packages ISPRA-FTA (Fault Tree Analysis) D1, HARP (Hazard and reliability Parameters estimation), ARIPAR, SOCRATES and part of STARS (SUN and RS-6000 versions).

The design of a calorimetric laboratory has been performed and experiments carried out, for training purposes, on COLUMBUS and DRACULA facilities at JRC (emergency relief systems).

For structural integrity estimation and monitoring, the probabilistic codes COVASTOL and RELIEF have been reshaped (transfer to Sicilian universities and training will follow soon) and experimentation on specimens with acoustic emission methods performed for training.

Project E: Protection of Cultural Heritage

Subprojects:

1. Characterisation of historical centre degradation and proposals of interventions: the case of Palermo, containing 12 Work Packages (Modules), performed by the University of Palermo (9) and JRC (3);
2. Cadastre of Sicilian architectural lithic materials and their mineralogical, petrographic and mechanical characterisation, containing 6 Work Packages (Modules), performed by the University of Messina (5), and JRC (1);
3. Characterisation of the degradation of stone monuments and works of art in Eastern and southeastern Sicily and proposals of interventions, containing 14 Work Packages (Modules), performed by the University of Catania (4).

Main results

The activity of the JRC has four clearly identified goals:
— development and application of a complete procedure for survey and structural analysis of historical buildings and their protection against seismic loads: Palazzo Geraci (18th century), located in the centre of Palermo, has been chosen as the test case: The complete survey of the Palace by numerical photogrammetry method has been made, its digital model implemented and its 3D reconstruction obtained from photogrammetric data, with possibility of virtual navigation; the response of the building to static and dynamic loads calculated and the its 1:2 scale model designed.

The large scale model will be reconstructed in Ispra, using properly chosen Sicilian material (limestone), and tested at the ELSA laboratory (reaction wall) with simulated earthquakes. In the last phase of the activity, consolidating elements will be designed, produced, installed on the model and tested.
— application of optical inspection methods for monument inspection:
The numerical photogrammetry survey and the vibration detection and measurement by laser technique performed on Fontana Pretoria (16th century) and on the ancient S.Offizio jail situated in the Palazzo Steri block; data are being processed;
— contribution to mechanical characterisation of stone materials: A non intrusive optical technique, based on the use of ESPI (Electronic Speckle Pattern Interferometry) and allowing higher precision, is being applied on stone specimens, sent by University of Messina, for their characterisation: The ESPI system has been tested after customisation;
— design and realisation of a multimedia data and image archive with hypertext facilities: The general architecture has been designed and implemented on Internet: Data and image format have been defined.

Project F: Reference Values of Trace Elements in Inhabitants of Sicily Region

This project has no subdivision in subprojects and contains 7 Mosules, performed by the University of Catania (1), the University of Messina (1), the university of Palermo (4) and the JRC (1).

Main results

Work is well advanced. After the preparation and distribution of the forms for the collection of information on sample people and of the document with the description of sample collection methodology and requirements, the studies for the control of pre-analytical factors have been carefully performed. The material for collection of blood, urine and hair samples have been sent to the Universities and the sample collection started. The methodology for statistical treatment of data is now ready.

Procedures and materials have been adopted that assure the absence of any contamination of the samples: The results of the project will therefore provide reliable measurements of trace elements in the Sicilian population.

Photovoltaic Component Testing

ISEI continued the photovoltaic component testing for industry. The following companies submitted PV module types for qualification testing to the IEC 1215 standard:
— ASE Americas (Germany) - 3 types
— BP Solar (United Kingdom) - 1 type
— Eurosolare (Italy) - 3 types
— Flachglas Solartechnik (Germany) - 1 type
— Kyocera Corporation (Japan) - 5 types
— Solel Energy (Denmark) - 2 types

Revenues from this work totalled 116100 Ecu. All of the above manufacturers submitted modules based on crystalline silicon technology. There was only one request for qualification of thin-film silicon modules, which was not pursued.

Modules from two of the above producers failed to meet qualification test requirements. One failure was due to poor control of the module lamination process. The manufacturer reviewed the lamination processes

and submitted an improved module which achieved qualification. The second failure was due to deformation of a lower-cost electrical junction box attached to the module. The manufacturer discontinued use of that junction box.

The results of qualification tests from 1990 were published at the 13th European PV conference in Nice, October 1995. Result of qualification tests on 80 module types were summarised. These data will be submitted to IEC Technical Committee 82, WG-2 Photovoltaic Modules - which developed the IEC 1215 standard.

The question of maintaining type approval following design changes is of obvious importance to PV module manufacturers, who continuously seek to lower the costs of their products.

The results published at Nice will also be used to determine what tests are required to maintain type approval following changes in materials, components and production processes used in module construction. The ESTI laboratory aims to reduce qualification testing costs so as not to stifle innovation.

That qualification by the ESTI laboratory is seen as a goal for PV module producers is evidenced by the requests for testing work to be performed in 1996. The test facilities are booked for six months in advance. The following companies will be submitting crystalline silicon modules in 1996:
— BP Solar (United Kingdom)
— Eurosolare (Italy)
— Siemens Solar (Germany)
— Pilkington Solar (ex - Flachglas Solartechnik)
— AstroPower (USA)
— Solar Energy (Malta)
— Solarex (USA)
— Solec (USA)
— Solel (Denmark)

Calibration of Reference Devices

During 1995 ESTI calibrated reference cells and modules used by many photovoltaic industries, such as BP Solar, Siemens Solar and Solarex, required for their ISO9000 Quality Assurance Programme.

4 INFORMATICS SERVICES

4.1 DISTRIBUTED INFORMATICS AND COMMUNICATION SERVICES

The informatics services are provided on a customer/ contractor basis, and therefore the services provided in 1995 were those that had been negotiated with our customers in 1994. They were a slightly reduced set of services compared to 1994 due to that fact that a lack of staff had made it impossible to provide all that had been promised for 1994, and the proposals for 1995 were dimensioned accordingly. The negotiation process continued in 1995 in order to agree the services to be provided for 1996.

As a follow on from the two visits from an Informatics visiting group in previous years, a strategy document was produced for the unit which made a proposal for the mission statement, objectives and strategy. By the end of the year, however, the document was still in discussion.

Network Services

In terms of evolution of the existing JRCNet, the transport technology remained the same, but the supplier for Europanet was changed during 1994. This change introduced some perturbations to the service, but by the end of the year the network had returned to its initial stability. Different communications protocols were used by us over the JRCNet service, that allowed better printing for some administrative applications, and the extension of the Ispra local network into the Directorate General in Brussels.

During 1995, a plan for a JRC Corporate network was agreed that will interlink the different sites of the JRC. This will produce a secure network, primarily for administrative purposes. The network will use frame relay technology, and the various connections have been ordered. In relation to this, a frame relay connection was installed between the Ispra site and the Telecom Centre of the Commission in Brussels. The first experiences with this technology produced a very favourable impression. The existence of this connection will certainly improve the computer communications between the JRC and the rest of the Commission. The implementation of the Corporate network will cause changes on the various local area networks, but these will take place in 1996. On the Ispra site network some modifications were

carried out, including the installation of two new nodes, and a workstation server that allowed some general servers to have a privileged connection to the backbone. Network management tools have been installed providing much more control over some of the network components.

The Distributed Systems Management service has been eliminated, and those activities related to the Ispra site connection to Internet such as the "news" and "domain name server" have been developed within the framework of the site network service. In fact a JRC World Wide Web server was implemented in 1995 and made operational towards the end of the year. This server is a point of visibility for the JRC, having links to the Commission's Europa server, and links into the WWW servers that exist and are being developed in the research Institutes throughout the JRC.

Modern cabling systems were installed in several more buildings on the Ispra site in order to replace the traditional ethernet cabling ("thick" and "thin"), together with the necessary hubs.

The use of ISDN (Integrated Services Digital Network) services increased with additional basic rate connections being ordered. These were used for data communications purposes and for video-conferencing both from video-telephone and video-conferencing systems, as well as from PC and workstation systems.

Electronic Mail

A site license has been obtained for the ISOCOR X.400 product that runs on Personal Computers, UNIX systems and Macintoshes. This allowed us to install the product on a much larger number of systems in the JRC. The small development work that had been done with mail-enabled applications and workflow has been curtailed. The other activities of managing the gateways and "post office", as well as the mail broadcast service have contained as previously.

First tests were carried out with X.500 standards based directory services for obtaining external e-mail addresses. These produced positive results, and

suitable client software is being identified in order to bring the service to the user desktops.

Office Automation

At the end of 1994 it was decided to only purchase the GlobalView application to run on Personal Computers, as a first step in a movement towards a convergence with the Commission's strategy for office systems. The rate at which old Xerox systems were replaced by PCs was not as high as might have been expected. The help desk associated with this service was increasingly involved in problems related to the interworking of the GlobalView environment with PC applications. Given the strategic direction decided, specific efforts were made to develop the competence of the staff contributing to this service in the domain of PC applications.

The role of Corporate Informatics Services

The JRC Administration and Management rely on CIS services for the operation of all information systems of general interest. Activities are devoted to the support of statutory systems such as finance, accounting, inventory, staff and other systems of more managerial nature such as analytical accounting, cost attribution, contracts, assets & resources. In addition, help is given to the specialised Units located in Ispra i.e.Public Relations, Library, Human Resources, Security, Infrastructure and Workshop.

CIS concern is to run the hardware/software/data platforms at their best cost/performance/ dependability indicators, to renovate applications according to changes in the regulations, and most importantly, to contribute to the improvement of the administrative/managerial processes through the adoption of innovative informatic tools.

The plan of actions

In September '93 a report was addressed to the Board of Governors with the description of a multi- annual plan for the modernisation of the JRC administrative/managerial information systems.Such plan aims at the improvement of the internal work-practices through the penetration of advanced ICT tools. The plan asks for a total of 2.27 MECU investments over the '94-'96 period.

The steering idea

In large service-oriented organisations, the adoption of modern ICT tools and methods is reported to pro-duce some 15% reduction in service costs due to the progressive identification and abandonment of no-value-added activities. Other important advantages are obtained in terms of image, accountability, transparency, service quality, customer satisfaction, staff mobility and empowerment. One additional key factor is that ICT facilitates the process of change in the organisation and serves as catalyst for the introduction of new administrative and management practices.

The approach

The modernisation plan involves the solution of 41 "internal business problems" that were identified through an audit exercise extended to all our administrative, operational and managerial processes. A world-wide call for tender exercise was activated in order to capture the experience gained by other organisations in terms of proce-dure optimisation, process re-engineering, workflow manage-ment and associated informatics support tools. This led to the selection of a short list of suppliers of informatics support services which help our internal analysts in the deployment of the adequate information and office systems. In addition to the ICT
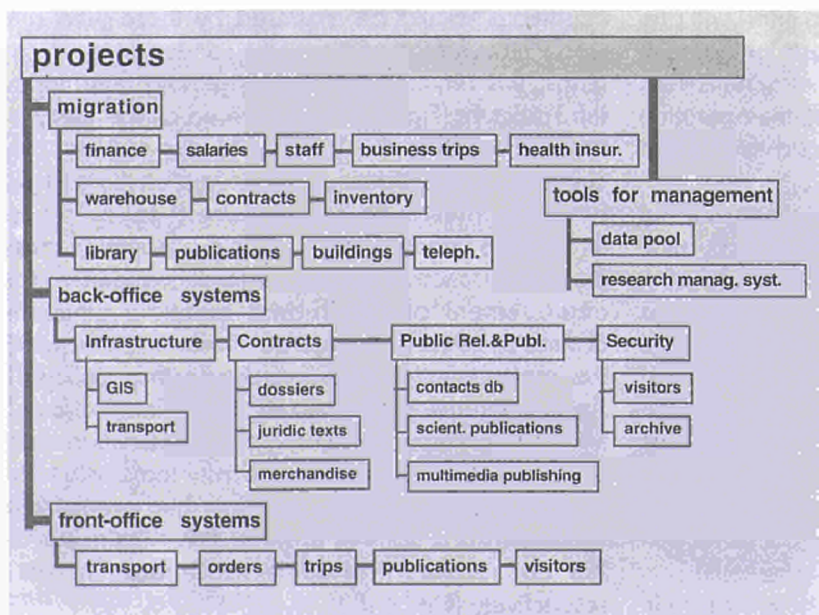
Fig. 4.1 The modernisation of Administrative/Managerial information systems

expertise, the modernisation effort requires the re-organisation of many aspects of the internal work-practices. This is achieved through the active and enthusiastic participation of the end-users in all phases and aspects of the implementation effort.

The developments

Essentially, the modernisation project develops along four major axis of actions (Fig. 4.1):
- the *migration* of all existing information systems from the old-fashioned mainframe server towards decentralised platforms,
- the construction of new tools for the management of corporate data, based on the concept of *data-warehouse*,
- the installation of advanced back-office systems in support of the work carried out by the various service Units, based on a *network of independent information systems;*
- the provision of advanced front-office systems that facilitate the interaction between service providers and end-customers, based on the adoption of *workflow/groupware technologies.*

The migration takes place either through the integration with the equivalent systems in force at the Commission (typical cases are the finance, staff, health insurance systems) or through the installation of new ad-hoc systems (typical cases are the geographical information system for the management of the Ispra site, contracts, library, publications, inventory). Beyond '97 this migration effort will produce a 0.5 MECU/year reduction of running costs due to the removal of the old software/hardware platforms. The staffing level devoted to the operation and maintenance of basic informatics services is also reduced by a 25% factor.

Data extracted from the regulatory/operational information systems are collected into a 'data pool' and made available to managers for their strategic, planning, accounting and speculative tasks. This 'information warehouse' complemented by adequate aggregation and correlation procedures, document archives, multimedia archives and sophisticated information navigation/discovery tools becomes the reference library of information about JRC facts and activities. The 'data pool' also serves as a switching facility in support of the exchange of data between the various decentralised information systems.

The administrative procedures that are necessary in order to request, produce and deliver services span across multiple functional units. Most verification/authorisation actions are based on the physical manipulation and the exchange of paper documents. Having all work in progress stored electronically, allows processes to include parallelism in tasks, to make steps visible and measurable, to increase interactions and communication between the actors. Moreover, immediate snapshots about the status of individual 'dossiers', bottlenecks, flaws in the procedures can be identified and the optimisation of the work can be facilitated. Procedures such as orders, contracts, visitors, transport, business trips are presented to the end-customer in the form of friendly prompters that support the journey of the request across the organisation till the delivery and the acceptance of the service item have taken place. Electronic procedures are based on workgroup and workflow management systems installed in the back-offices of the service Units and in the front-office workstations of the users.

Technicalities

The informatics architecture of the deployed systems reflects the need for an increased self-sufficiency for the users. Staff performing service activities should be enabled to design their own forms, procedures, reports and data flows with little help from informatics professionals. Moreover, the evolution of the applications according to changing conditions should be mastered by those who are responsible for the quality of the service. In technical terms, this requires that the supporting informatics infrastructure (Fig. 4.2) is reinforced conveniently in order to contain the building-blocks that can be customised and combined to accomplish the desired functionalities. Such reinforcement takes place through the standardisation of the desk-top platforms, the centralisation of the hardware/software/network management and help-desk functions, the co-ordination of the data base administration practices, the implementation of a common security policy.

Application developments rely on the integration of traditional components such as the transaction data bases and the personal productivity tools with new technologies such as the workflow and groupware systems. This is done in order to cover the needs at the corporate, individual and team levels, respectively (Fig. 4.3).

The achievements

The *GIS* project for the management of the Ispra-site infrastructures/facilities has reached its final delivery step. On top of the basic topographic maps, thematic aggregates are produced with alphanumeric data relevant to the management of buildings, offices, allocated staff, telephone/fax/photocopier devices, cleaning, maintenance interventions and other services. Its utilisation is now considered in the framework of new organisational arrangements of the Ispra-site logistics.

The new *Library* system has been installed and loaded with the historical catalogues derived from the old system. It provides query and application functions to the end-user, loan management, inter-library consultation and loan facilities, accounting and service follow-up. This will be followed by intense training and customisation sessions once the Library itself will be moved to a new building.

The new *Publications* data base is now loaded with the historical bibliographic data and is ready to collect the new submissions. As a by-product, the Bulletin of JRC Publications in its version for final distribution is produced.

The new *'Contacts'* data base for use by our Public Relations service is operational. It collects relevant information about meetings, events, interest groups, mailing lists according to the specifications required for the management of JRC contacts with Member States authorities, visiting and control bodies, scientific and industrial circles.

The *'staff'* and *'salaries'* information systems have been successfully migrated to independent and cheap platforms. During '95, the parallel operation of both the new and the old system has been carried out. This verification allows to check the consistency of results across complex procedures such as promotions, changes in salary levels and indemnities.

The *'contracts'*, *'business trips'*, *'staff allocation'* information systems have been migrated to independent and cheap platforms. The performance of those new systems will be checked against the old ones and if the verification proves successful, the replacement will take place.
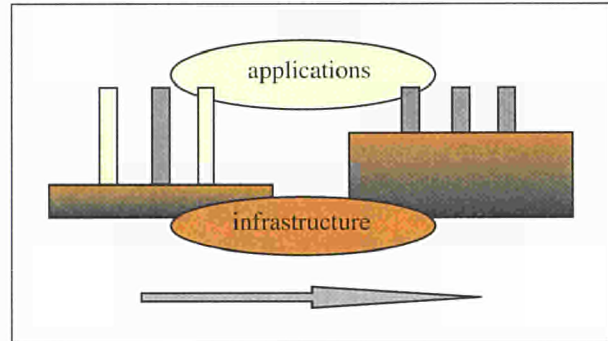
Fig. 4.2 The evolutionary development of business software applications

The new *'telephone'* and *'transport requests'* databases are also in an advanced phase of development and are likely to enter operation by early '96. A new car transport reservation, management and accounting system has been designed that eliminates a great deal of paper work and human interventions. The end-users and the operators of the transport service are supported by a workflow manager that supervises the circulation of the requests and their follow-up.

The information system of the *Security Service* of the Ispra site has been redesigned in order to improve the overall efficiency as perceived by our visitors. In particular, the new system includes new logistic arrangements at the reception desk integrated with the data bases on badges, cars, movements. The security-check function is best served by an electronic information base. The system has its own
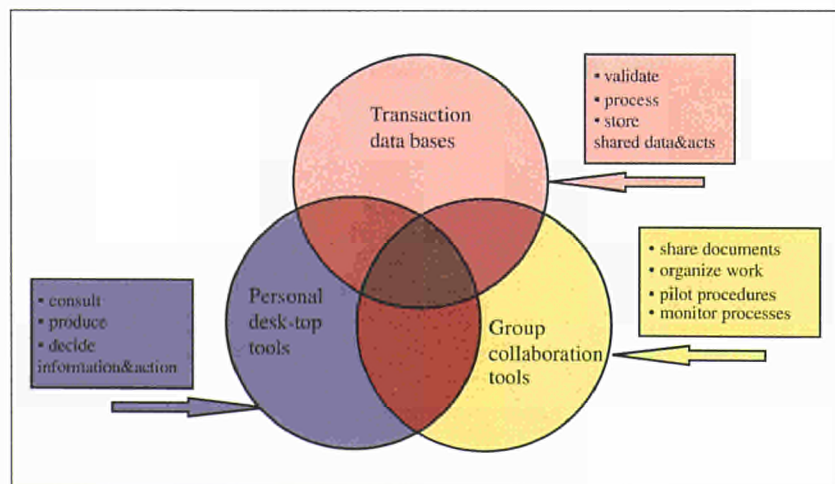
Fig. 4.3 The three domains of modern business software applications

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workflow manager for the production and the follow-up of the 'visitor' request. The system is planned to enter operation early '96.

A joint project with membership from DG XIX, DG XX and JRC has been set-up for the production of SINCOM2, the *new financial & accounting information system* in force at the Commission.
The JRC contribution has been considered essential in the light of the experience gained in the design and operation of the existing Sibeca system. The project has entered the detailed specifications phase which will be followed by the development and the demonstrator phases planned for mid '96. The demonstrator operated at the JRC will serve as test-bed for the final version of the product to be deployed in all Commission services. The JRC is active in several project activities such as design & functional coherence, security & infrastructure, conversion & transition, quality management.

One major effort is undertaken in order to introduce modern workflow management techniques in the *'order'* process for the procurement of goods and services. This is the most complex and pervasive administrative procedure in the house. In order to check the technical feasibility of the approach, a fully paperless and machine-assisted prototype has been demonstrated to the administrators. The project now requires the analysis of the details of the procedure as executed by the various actors (requester, authorising officer, financial controller, accountant, inventory, custom, warehouse) in the spirit of a new re-engineered process. For this purpose, a task force has to be set-up with the mandate of devising new work-practices, test environments and the final deployment of the system. The ISEI and ITU Institutes volunteered to act as leaders of this experience.

PCs, servers and network platforms are to be managed in a co-ordinated way in order to support applications of common interest and the sharing of information. For this purpose, a *PCs management* project has been set-up. The objective is to gain experience in the configuration and the operation of distributed platforms and client/server systems. The result of this exercise is meant as an orietation for future service arrangements as regards the difficult problem of the management of distributed informatics.

5 OTHER PROJECTS

The Ispra Ecocentre Project

5 OTHER PROJECTS

THE ISPRA ECOCENTRE PROJECT

Low Energy Retrofitting of Elderly Buildings

When the 1994 Annual Report went to press, retrofitting work had just started on the large experimental hall of the ESTI lab. and plans had been finalised for the cafeteria building (Mensa). By the end of 1995, work on both buildings was nearing completion and monitoring of their performance could resume.

At the time of writing, January 1996, it is too early to say whether the energy consumption of these buildings has been reduced as much as expected. A considerable improvement in the internal climate of the Mensa is already apparent, however. For the first time, there have been no telephone calls to the maintenance staff, on cold days, complaining of unsatisfactory conditions. The success or otherwise of the natural ventilation system and roof shading can only be investigated in the summer.

During 1995, the work of perfecting the monitoring system continued, with the preparation of analysis tools, interfacing of meteorological files, and maintenance of sensors. The data obtained will only be significant, however, once the retrofitting has been fully completed.

Long Term Energy and Environmental Management at the JRC Ispra.

The ECOCENTRE activity will not come to an end with the completion of the present retrofitting programme nor with the completion of the two new low energy buildings currently under construction. Efforts will continue to improve the environmental impact of the Centre, both by reducing energy consumption and by returning as much of the site as possible to a more natural state. To provide a framework for the whole activity, the JRC, with the help of ISEI staff, has drawn up a "Mission Statement" (S.P.I. 95.51). This sets out objectives and indicates actions that will be undertaken to achieve them. By publishing such a statement, the Centre will be making a public declaration of intent.

In order to be able to monitor progress in implementing the policy set out in the Mission Statement, various environmental indicators will be required. A start has been made on defining these in a report to be published by ISEI in 1996.

Second ECOCENTRE Status Report

A full description of all activity to date will shortly be available in a Status Report prepared by staff from ISEI and the Environment Institute.

Several JRC meetings were held on the Master Plan and Building Regulations resulting in the publication of a paper (SPI 95/25). A paper was prepared for the visitors attending the Schumann day exhibition.

A working paper was prepared for a study of the "Competition for Ideas" focused on the new design of the Mondovi Hospital (Italy), in collaboration with USL n. 16 and ENEA. A paper was presented by R. Colombo and H. Langenkamp, entitled "Advanced Insulation Building Technology" at a conference in Espinho, Portugal.

Inter-institutional Activities

The ESTI dark room was lent to the Environment Institute during an international UV Irradiation Sensor Campaign to carry out accurate calibrations of the participants' sensors. The measurements were carried out on the roof of the Solar House.

6 TESTING FACILITIES

6.1 T.E.M.P.E.S.T. - LABORATORY (Thermal, ElectroMagnetic & Phisical Equipment Stress Testing)

In order to qualify newly developed components (from JRC, other R/D laboratories and industry), TEMPEST (Thermal, ElectroMagnetic & Physical Equipment Stress Testing) Laboratory is equipped with various devices allowing the testing of equipment's under various thermal and mechanical stresses as requested by the customers or under international standards such as IEC. These devices allow thermal and/or humidity tests from -65°C to +150°C (humidity from 20% to 98%) generated with three climatic chambers with volumes from 30 litres to 1700 litres. The second set of equipment composed of two shakers permits the generation of mechanical vibrations and shocks up to 30g's. Due to an increasing demand of the various users of this laboratory and due to the new European regulations concerning electromagnetic conformity of the equipment, the laboratory was equipped, during 1995 with several devices allowing the test of the immunity (conducted and radiated) of the equipment.

These devices can be presented as follows (Figure 6.1):
- an isolated chamber of $1m^3$ allowing the generation of radiated perturbations;
- a burst generator;
- a voltage variation generator;
- a surge generator;
- an electrostatic discharge generator.

These various devices allow the testing of the equipment's immunity under the following IEC standards:
- Voltage Fluctuations, Voltage Dips and Short Interruptions: IEC 1000-4-11;
- Surge: IEC 1000-4-5;
- Fast Transient Burst: IEC 801-4 (IEC 100-4-4);
- Conducted Radio Frequency Disturbances: IEC 1000-4-6;
- Electrostatic Discharges: IEC 801-2;
- Radiated Electromagnetic Field: IEC 1000-4-3.

In the next phase (in 1996), it is expected that TEMPEST laboratory will be equipped with the necessary devices to conduct also emission measurements in accordance with the various IEC and EN standards: this includes the installation of an anechoic chamber as well as an EMI receiver. Due to the increasing demand of tests in the area of nuclear safeguards, agricultural anti-fraud and specific technical collaboration projects, private industry and other research centres, and due to the new regulations occurring in Europe, TEMPEST laboratory will start in February 1996 its accreditation under quality assurance system EN 45001 for various tests available in its facilities such as thermal, humidity and electromagnetic in accordance with the corresponding IEC standards. This will allow the laboratory to be recognised as an official testing laboratory.
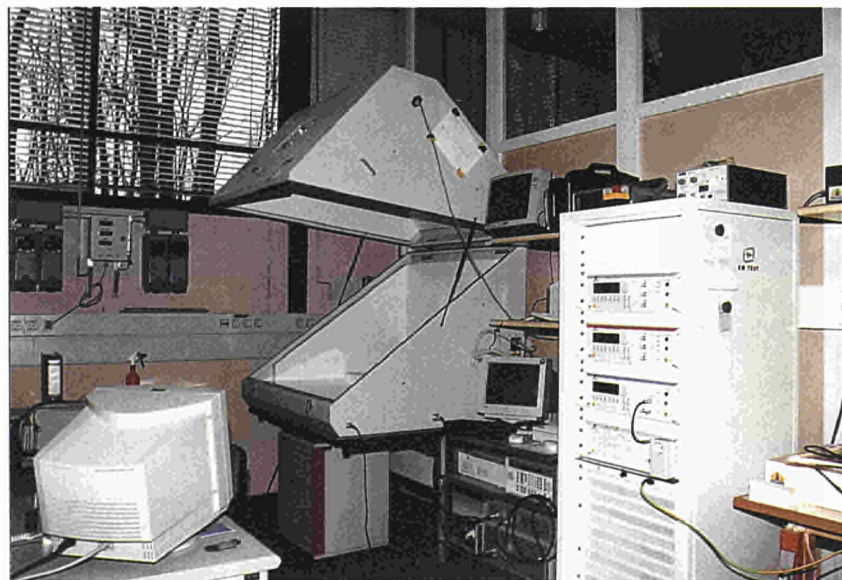
Fig. 6.1 View of the immunity test facility of TEMPEST laboratory

The TELEMAC Laboratory for Teleoperation and Robotics is dedicated to the Computer Simulation of Remote Handling operations and to the validation of numerical simulation results from experiments on mock-ups, with particular attention to the heavy robotics interventions on large and complex systems.

The laboratory includes an advanced CAD/CAE System and a large experimental facility ROBERTINO (Figure. 6.2), a Cartesian manipulator (Gantry Robot) for heavy robotics, with a working space of 6.5 m · 3 m · 2.2 m.
The simulation process is dedicated to the computation and optimisation of procedures and trajectories, on the basis of models from a CAD system (CATIA) and a 3D Kinematics simulator for robotics (TELEGRIP).

The experimental process for validation is performed on mock-ups and tools prototypes by using the facility ROBERTINO and the related auxiliary equipment's. The facility ROBERTINO has been recently upgraded in order to improve the dynamic behaviour during the movements, in particular for avoiding induced vibrations. The pay load has been increased to 6 tons, resolutions and repeatability have been ameliorated to 0.1 mm.

A new control system, based on VXI-bus with VX-Work as operating system, has been developed at the same time, following the experimental requirements of modularity and adaptability and in conformity with the most updated standards, as Safety Critical Computer System.

The Laboratory allows a variety of studies in robotics, in particular an efficient feed back in the design process of Remote Handling equipment's, test of various components, tools and sensors, development and testing of Control Systems and Remote Handling Workstations, and dependability assessments of Remote operations and autonomous processes, by taking into account software and hardware aspects.

The Laboratory, initially conceived for studying the Remote Handling Maintenance of the future Fusion Reactors in the frame of the Thermonuclear Fusion Programme, is now available for assessing the feasibility, safety and reliability conditions of industrial processes.

Fig. 6.2 The facility ROBERTINO.

.3 ESTI - EUROPEAN SOLAR TEST INSTALLATION

The major development of the test laboratory was the accreditation programme. Accreditation to European Standard EN 45001 by COFRAC (Comité Francais d'Accreditation) is being pursued for the module qualification and device calibration activities.

This is a major improvement both in the status of the ESTI laboratory, and in the service offered to its clients. With the diffusion of the ISO 9000 series of quality control standards through industry, there is increased demand for specialised laboratories providing technical support. For example, following accreditation, the ESTI laboratory may authorise "CE" markings on PV modules.

The major effort during 1995 was the creation and implementation of quality control procedures meeting the EN 45001 requirements for a laboratory implementing the IEC 904 and IEC 1215 standards. This brought about a general improvement in the documentation and instrumentation of the testing and calibration facilities.

Of great importance in the laboratory accreditation scheme was the creation of a metrology laboratory for calibration of electrical measurement equipment and temperature sensors. All equipment used in the testing and calibration activities will be periodically calibrated in-house. Accreditation may subsequently be sought for the metrology laboratory itself.

Chains of traceability to reference devices were implemented for irradiance, voltage, current, and temperature sensors used in the IEC 904 series of standards (performance measurements, spectral response and temperature coefficient determinations etc.) and in the calibration of the ESTI sensor.

Three out of seventeen tests described in IEC 1215 will not be presented for accreditation at the first external audit. These are UV Exposure (due to the absence of accurate and reliable UV sensors), the outdoor cell operating temperature determination (NOCT - due to the absence of a certified, calibrated wind speed and direction sensor), and the hail impact test (due to the difficulty in calibrating hail impact velocity).

Improvements were made to the following test facilities. The visual inspection laboratory was equipped with photographic arc lamps (colour temperature 5200K); walls and ceiling were painted black to reduce reflections. Photographic capabilities were improved with a CCD camera fitted to a mobile stereo-microscope; video monitor and video printer.

Control systems for the accelerated climatic test chambers (used for thermal cycling, humidity freeze, and damp heat tests) were upgraded using embedded microprocessor controllers. The microcontrollers can communicate via a standard serial interface with a PC (e.g. for transmission of process control information) but operate independently of a PC. This greatly improved the reliability of test programme execution, reducing the time required to complete the above tests.

Given this positive experience, a microcontroller will be installed in the electrical temperature coefficient determination system, permitting automatic operation Instrumentation required for the mechanical load and twist tests was simplified to give a visible indicator of module electrical continuity or the presence of ground faults.

Other minor improvements to laboratories included the installation of soft flooring material to reduce the likelihood of accidental damage during module handling, and the purchase of trolleys for transporting modules of increasing size (mainly used in architectural applications).

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LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

A.C.	Alternative current
A.I.M.A.	Azienda di Stato per gli Interventi nel Mercato Agricolo
A.S.A.	Advanced Storage Area
ACTS	Advanced Communication Technologies & Services
APET	Accident Progression Event Tree
ASG	Aviation Safety Group
ATC	Air Traffic Control
ATCO	Air Traffic Control Operator
ATM	Air Traffic Management
BE-EJTs	Benchmark Exercise on Expert Judgment Techniques in PSA Level 2
BEAMES	Building Energy Auditing Management Expert System
BNFL	British Nuclear Fuels Limited
C/S	Containment and Surveillance
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAVIS	Computer Aided Video System
CBT	Computer Based Training
CDCIR	Community Documentation Centre on Industrial Risk
CEA	Commission pour l'Energie Atomique
CEO	Centre for Earth Observation
CIS	Community of Independent States
CMF	Controllo Materiali Fissili
COGEMA NPH	COGEMA Nouvelle Piscine la Hague
COSIMO	Cognitive Simulation Model
CRM	Crew Resource Management
DC	Direct Current
DFD	Deutsches Fernerkundungsdatenzentrum
DLR-	Deutsche Forschungsanstalt für Luft-und Raumfahrt
DSM	Demand Side Management
DYLAM	DYnamic Logical Analytical Methodology
ECEEE	European Council for an Energy Efficient Economy
EDF	Electricite de France
EDS	Euratom Safeguards Directorate
EEOS	European Earth Observation System
EIA	Environmental Impact Assessment
EIREDA	European Industry Reliability Data Bank
EIS	Environmental Impact Studies
EJ	Expert Judgement
ELSA	European Laboratory for Structural Assessment
EMI	ElectroMagnetic Immunity
EN standards	European Norms standards
ESD	EURATOM Safeguards Directorate
ESPI	Electronic Speckle Pattern Iterferometry
ESSI	European Systems and Software Initiative
EU	European Union
EWSE	European Wide Service Exchange
GIS	Geographical Information Service
HC&M	Human Capital and Mobility Programme
HERMES	Human Error Reliability Method for Event Sequences.
HF	Human Factor
Ho.M.M.	Horizontal Multisensor Module
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organisation
ICT	Information and Communication Technologies
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IMSS	Interactive Mobile Surveillance System
INMM	Institute for Nuclear Materials Management
IPPE	Russian Institute for Physics and Power Engineering
ISAD	ITER Sequence Analysis Data Base
ISDN	Integrated Services Digital Network
ISEI	Institute for Systems Engineering and Informatics
ITER	International Thermonuclear Experimental Reactor
ITER-IDR	ITER Interim Design Report
ITU	Institute for Transuranium Elements
JAERI	Japanese Atomic Energy Research Institute
JPEG	Joint Photographic Expert Group
JRC	Joint Research Centre
KE	Knowledge Engineering
KFA	Kernforschungsanlage (Nuclear Research Centre)
LaSCo	Laboratory for Surveillance and Containment
LBIC	Light Beam Induced Current
LBIV	Light Beam Induced Voltage
LWR	Light Water Reactor
MAHB	Major Accident Hazards Bureau
MARS	Major Accident Reporting System
MCDA	Multiple Criteria Decision Aids
MECU	Million of ECU
NET	Next European Torus
NUFF	New Unified Field Format
NUHOMS	Horizontal storage module for spent fuel
PSA	Probabilistic Safety Assessment
PV	Photovoltaic
PWR	Pressure Water Reactor
QCT	Quantitative Causal Trees
RESOLV	Reconstruction using Scanned Laser and Video
RF module	Radio Frequency Module
RoHMI	Design of Robust Human Machine Interaction

SCCS	Safety Critical Computer Systems	TAME	TAnk MEasurement
SEAFP	Safety and Environmental Assessment of Fusion Power	TCAS	Traffic Collision Avoidance System
		TELEMAC	Laboratory for Teleoperation and Robotics
SILab	Seals and Identification Techniques Laboratory	TMR	Training and Mobility Research
		UCLAF	Co-ordination Unit for the Fight against Fraud
SMART	Semi-autonomous Monitoring And Robotics Technologies	UIMS	UCLAF Integrated Information Management System
STARS	Software Tool for the Analysis of Reliability and Safety	UMS	Unattended Measurement Station
SYCLOP	System of control for locations and objects by parabola	UPS	Uninterruptable Power Supply
		VRML	Virtual Reality Modelling Language
T.E.M.P.E.S.T.	Thermal, ElectroMagnetic & Physical Equipment Stress Testing	WG	Working Group
		WWW	World Wide Web

The Annual Report 1995 is the first report concerning the framework 1995-1998 and reports on the institutional activities contributing to the programme lines "Environment and Climate","Non-nuclear Energy", "Nuclear Fission Safety" and "Fusion" as well as institutional support to the Community policies of DG I, III, VI, XI and XVII. The competitive activities of the Institute concern support to DG XI and XIII, participation in shared cost actions, in the Human Capital and Mobility Programme as well as work for third parties. The activities of the informatics services are reported and the testing facilities available at the Institute are described.

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