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Article

Importance of the demonstration/participation of end users for the success of the EURANOS project

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ABSTRACT **Within the EURANOS project, 17 different demonstrations were conducted. The objective of these demonstrations was to apply a certain product in the operational environment of an emergency centre and to check its performance either in particular exercises or in their daily use. As a result of a demonstration feedback to the development team was provided, highlighting requirements for the further development of the product – if necessary. A second key pillar in the project was the intensive involvement of the RODOS Users Group (RUG) in the research activities. In particular all work packages related to the further improvement of the RODOS system have been observed by the RUG. In some of the work packages, the RUG was involved from the beginning and participated even in the design documents for the software development. Both mechanisms, the demonstrations and user involvement, guaranteed that the end user's perspective was considered throughout all phases of the EURANOS project.**

1. Introduction

The demonstration activities were one of the key elements of the EURANOS project. They were highly important for both, directing the RTD activities as well as establishing the RTD products' capabilities in the actual operational environment. The specific aim of the demonstration activities was to determine which of the tools, methods and approaches to be used within emergency preparedness in Europe developed in previous Framework Programmes and/or developed and enhanced within EURANOS project are ready for actual operational applications.

At the same time, the aim of the demonstrations was to – using the feedback from expected future users – identify which of the tools, methods and approaches need further development and refinement. The scope of the demonstration activities in the EURANOS project encompassed activities in the various RTD work packages. In each of these work packages, the tools (in some cases specific elements of the tools), methods and approaches have been demonstrated under

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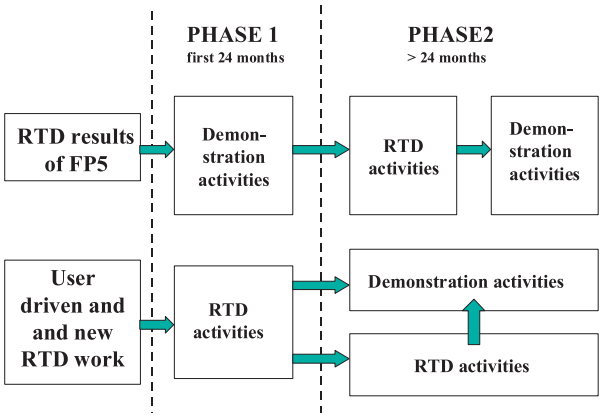

Figure 1 – ***Structure of the interaction between RTD and demonstration activities within phases 1 and 2 of EURANOS.***

conditions which reflected as close as possible future operational uses of the tools demonstrated.

The demonstration activities have been defined in both Phase 1 and Phase 2 of the EURANOS project. The demonstration activities of Phase 1 of the project were mainly devoted to methods and tools which were developed prior to the initiation of EURANOS. In some cases however, smaller scale development and finalisation of the tools have been undertaken within EURANOS before the demonstration within the Phase 1.

The demonstrations carried out within Phase 1 together with the interaction of the RUG has led to significant modifications of the work programme from the second year onwards. In particular the user interaction with the RODOS system (Ehrhardt, 2000) was criticised in the light that manpower and resources in emergency management organisation are reduced from year to year and therefore the operation of the decision support system has to be assured also with a very limited amount of trained operators and experts. In particular in the first phase of the emergency, an easy and fast access to results is essential to have enough time initiating emergency actions such as evacuation, sheltering and distribution of iodine tablets. Taking these aspects into account a newly structured user interface was developed using state of the art IT technologies with its implementation in JAVA (object oriented programming language). This new interface facilitates direct error management of the user's input and guides him through a series of easy to understand input frames. In addition, the graphical representation of results was improved.

Demonstrations in the second phase concentrated on the usability of the decision aiding component of the RODOS software, small scale exercises dealing with releases other than from a nuclear power plant and the two handbooks on assisting in the management of contaminated food production systems and contaminated areas, which have been developed within the EURANOS project. In these two demonstrations of the generic handbooks not only the final product was exercised but also the process how to establish the best environment for the usage of these handbooks. This comprises the set-up of stakeholder panels which are an integral part of the successful application of the handbooks following a nuclear or radiological emergency. The two handbook demonstrations provided valuable feedback for the further improvement of the final documents available by the end of the EURANOS project.

The final demonstration was devoted to the re-engineered RODOS system. Following a training course which provided the basis for the understanding of the structure and operation of the new system, the end users installed the system in their national centres und demonstrated them under test circumstances. Feedback from the demonstration was considered in the final version delivered in June 2009.

2. Demonstrations

Demonstrations carried out in the EURANOS project consists of three main steps. First, the demonstration notebook is defined which defines the main tasks to be carried out during the demonstrations and identifies the evaluation criteria. The second step is the demonstration itself which is performed either by individual organisations or in clusters of countries which was the case for the demonstration of data exchange between decision support systems installed in neighbouring countries. Finally, the findings will be summarised and evaluated resulting in recommendations from the operational user community how to proceed further with the tool demonstrated.

The following list provides an overview on the seventeen demonstrations carried out.

Title	Objective of the demonstration
Probabilistic estimation of source terms from in plant data (SPRINT)	To demonstrate the use of SPRINT within the emergency organisation (plant or site-level as well as national level) to determine the feasibility of this tool for early prediction of the source term and to resolve related issues. To determine the appropriateness and related conditions for operational use of SPRINT To collect feedback from plant operators, TSC staff and decision makers (a/o authorities) in order to produce recommendations on further refinements or enhancements needed.

Title	Objective of the demonstration
Networking and processing of on-line data in decision support systems	To verify the operability of the systems and including the compatibility of the formats to enable RODOS system to adopt the data and use it in its predictions: Specifically, the aims of the demonstration are to verify: • Transmission of on-line radiological and meteorological data from monitoring systems • Request and transmission of meteorological forecasts from national weather services • Further processing and adoption of both types of data within RODOS, in particular in the different operating modes.
Visualisation and evaluation of on-line data in decision support systems (RtGraph)	To evaluate RtGraph, RODOS' data visualisation tool for its usefulness and possible uses by emergency support organisations. To provide specialized user's perspective feedback to the development of the RtGraph on possible needs and ways to enhance and optimise the products to achieve the functionality needed.
User interfaces of decision support systems 1 – UI provided with patch 6.0	To assess the adequacy and usefulness of the RODOS user interface that was delivered within the RODOS patch #6.
User interfaces of decision support systems 2 – RODOS Lite	To assess the adequacy, usefulness and robustness of the new RODOS Lite user interface.
Adequacy of the system results and their forms of presentation within the decision making process	To establish to which extent RODOS (or another DSS) fulfils the needs of an emergency centre in providing the information that is needed for the support of the decision making during various phases of nuclear emergencies.
Operation of decision support systems in a cluster environment with remote users of different access rights within one country	To demonstrate the use of the RODOS system with a central installation of the system in a national cluster with several external (*i.e.* remote from the central installation) RODOS users with different roles and rights.
Shared use of and data exchange between decision support systems installed in neighbouring countries	To demonstrate the use of the MODEM server for the exchange of information between countries using decision support systems, RODOS and ARGOS in this case. To investigate the benefits and possibilities to enhance the decision support while continuously (*i.e.* discretely, but in relatively short intervals) obtaining the data for a country where an accident occurred, and using those within RODOS.
Evaluation of the appropriateness of the use of the ASTRID system for source term estimations based on in-plant data	To evaluate if the ASTRID system answers to potential end-users needs in emergency situation.
Small projects	To demonstrate the usability and usefulness of RODOS to support the decision making related with releases other than major NPP accidents.
Testing atmospheric capabilities of RODOS system installations through ENSEMBLE atmospheric dispersion exercises	To explore in RUG or elsewhere the interest in the emergency management community for having access to results for food concentrations, intervention levels, etc, of a similar form to those in ENSEMBLE for air concentration and deposition and second to attract all emergency management organisations to make use of the ENSEMBLE facility and to test the implementation and use of the MATCH model (inside RODOS) in the various countries
Demonstration of the usefulness and usability of the evaluation techniques in RODOS - Web-HIPRE	To demonstrate the usefulness and usability of the Web-HIPRE (HIerarchical PREference analysis in the World Wide Web) Java applet for decision analytic problem structuring, multi-criteria evaluation and prioritisation as part of the RODOS system for the later phase problems

Title	Objective of the demonstration
Application of the MOIRA DSS to evaluate rehabilitation strategies for contaminated freshwater bodies at the local or regional levels	Testing the applicability of the MOIRA system for the definition and analysis of a variety of appropriate strategies for the long-term management of contaminated freshwater bodies, for both lakes (local scale) and rivers (regional scale). Testing the validity of the MOIRA system as a tool in the decision making process able to incorporate inputs from different ranges of stakeholders.
Demonstration of the usefulness and suitability of the hydrological dispersion module (HDM)	To assess whether the use of hydrological dispersion model (rivers) is of interest for emergency preparedness and how such a model would enable faster and better decision making at emergency centres. This was exercised with the help of a Polish case study
Generic Handbook for assisting in the management of contaminated food production systems in Europe	The first part of the demonstration aimed at testing the usefulness of the Handbook for developing a management strategy for one or more scenarios involving contamination of the foodchain. The objective of the second part of this demonstration was to assess the value of engaging stakeholders in applying the Handbook.
Generic Handbook for assisting in the management of contaminated inhabited areas in Europe	To test the usefulness of the Handbook for developing a management strategy for one or more scenarios involving contamination of an inhabited area
Basic Evaluation of JRODOS	To evaluate the reengineered RODOS system software, from the perspective of its usability and its robustness. Further to corroborate that the RUG requirements for the reengineered RODOS software are adequately addressed.

In this special issue, the demonstration about the handbooks and the MOIRA system are presented in detail. This summary concentrates on three important demonstrations focusing first on a tool that has been developed with the 5th Framework program, the SPRINT software, second on the user interface of the RODOS system and third on the re-engineering of the RODOS system.

2.1. SPRINT

SPRINT is a tool to define source terms based on in plant information. The source term defined is of probabilistic nature which means from a set of pre-defined source terms those which are most likely representing the accident sequence will be selected together with their probability of occurrence. This requires, that a priory, source terms have to be defined for example with the help of a Probabilistic Safety Assessment study of level 2 (Gindon and Kinniburgh, 2004).

The tool was regarded as “fit for purpose” by the 7 organisations demonstrating it. The probabilistic character of the prognosis was well accepted and the concept is clear for the users. Information generated by SPRINT alerts the user to the existence of alternative possible plant states and provides quantitative measure for their likelihood. No significant user problems were experienced during the exercise. SPRINT was able to consistently identify the initiating events and the most likely source term. The tool was found easy to use, even by persons of limited technical experience. In the opinion of users the evaluation of source term is

quicker as compared to the currently available methods, and the generated results are comparable or even better. There was also no controversy among the users regarding the availability of data needed for SPRINT as input. The majority of plant status data are available at the location where SPRINT is or might be used or can easily be provided. Few concerns were noted regarding the availability of specific information but are mostly of technical nature and a solution very likely. The source term characteristics predicted by SPRINT were generally in agreement with the information available from deterministic analysis, however, some differences were observed. Enhancement of the model to resolve these deficiencies would require further effort. This could, in principle, be achieved with no impact on the operational efficiency of the tool. Some directions for such improvements were indicated in the project summary report.

Besides these general findings, also specific points were raised:

- provide better user interface for tracking the time evolution of given answers;
- Provide the possibility to adjust pre-calculated source terms to an actual accident evolution;
- specific SPRINT user interactions should be formulated in cooperation with potential users to avoid misunderstandings;
- the network should be set up in such a way that it does not need information from previous accident phases;
- it could be considered whether it is possible to develop an on-line diagnosis mode in SPRINT in which important plant parameters are read automatically from the plant computer;
- graphical illustration of release paths could be helpful.

In this way, the overall performance of the tool could be evaluated together with suggestions of the potential user community how to improve the tool in future. This was in-line with the overall concept of work inside EURANOS to define future research and development activities by the end user and not solely by the research community.

2.2. RODOS-Lite

The objectives here differed from those of the SRINT demonstrations. The user interface was identified as crucial and not appropriate within a demonstration in the first phase of EURANOS. Consequently, a work package was set up to improve the user interface. Work therein was heavily influenced by the RUG who provided input and requirements for the new design. The demonstration thus focused on the fact to which extend the requirements set up by the end users had been realised in the final product. This final product, named RODOS-Lite user interface (Müller *et al*., 2010), was and is an integrated part of the RODOS system

in all its realisations, either on HP, Linux or, with the re-engineered system, also Windows operating system.

The topics addressed in the demonstration focused on two areas with all in all 14 individual items:

A) General issues:

1. general assessment of the entry windows;
2. user friendliness of the interface;
3. assessment of the entry/results windows (clarity of guidance provided);
4. number of actions necessary to access or modify a particular parameter;
5. description of the control buttons and input windows/parameters;
6. comfort (easiness) during operation;
7. robustness of operation;
8. other general issues.

B) Specific issues

9. error tolerance and management;
10. system messages;
11. help functions and windows;
12. national language support;
13. user instructions;
14. other specific issues.

Nine countries with 12 organisations participated in this demonstration. National reports contained detailed information on the demonstration and findings that were forwarded to the software developers for further improvement of the product. The RODOS-Lite user interface generally was well appreciated by all participants. RODOS-Lite, following a brief introduction, is applicable for those users with nearly no RODOS knowledge or even for fully untrained users.

Some criticism and requests for further improvement were presented in the detailed national reports and they were considered for the final release of the RODOS-Lite user interface at the end of the EURANOS product. In this way, the demonstration assured that the initial request of the end users were adequately considered and the final product fits the purpose of the operational and daily use in emergency centres.

2.3. JRODOS

The Java based re-engineered RODOS system, named JRODOS (Ievdin *et al.*, 2010), was one of the key end products of the EURANOS project. The re-engineering was initiated by the end users at the end of the Phase 1 and realised at

the early beginning of Phase 2 of the project. As RODOS was an important part of EURANOS, the success of the re-engineering of the RODOS system was important for the success of EURANOS in general. To demonstrate and evaluate the re-engineered RODOS system, 4 months before the end of the project, a demonstration was scheduled with the aim to assess the installation, overall performance and robustness of the new version and to test all functionalities by applying it to exercises or test runs. The assessment was expected to be done also in comparison to existing HP-UX/Linux installations of RODOS. The evaluation exercise should primarily focus on the re-engineered features of JRODOS such as:

- the user interface including RODOS-Lite;
- the possibility to define own model chains;
- the graphical result presentation;
- the new modus of importing weather data;
- the visualisation of weather data and real-time data;
- the graphical engine with GIS functionalities and import of geo-referenced TIF data sets;
- the possibility to connect to external GIS servers;
- the performance of the underlying models which were modified but should provide similar results (given the slightly modified data base and method how to calculate the underlying grid);
- the new web interface with the same look-and-feel as RODOS-Lite;
- the two new models IAMM and ERMIN, dealing with data assimilation and countermeasure modelling in inhabited areas, respectively.

The issues of relevance for this demonstration included:

1. Installation and customization
   a. Description of hardware used;
   b. Installation of JRODOS and the additionally required software on the chosen operating system;
   c. Description of JRODOS customization performed;
   d. Is the installation guide clear and easy to follow?
   e. Errors in installation guide?
2. General assessment of JRODOS
   a. Assessment of the graphical user interface;
   b. Assessment of the whole operation;
   c. Is the user guide clear and easy to follow?
   d. Errors in user guide?
3. Short assessment of the new functionalities;
4. Short assessment of the new B-user interface;
5. Performance of operation (also in comparison to existing RODOS installations);

6. Robustness of operation;
   a. Error tolerance and management;
   b. System messages;
7. Advantages/Disadvantages of JRODOS compared to HP-UX/Linux versions;
8. Will JRODOS be used instead of HP-UX/Linux version?
9. Other issues.

A total of 15 organisations expressed their interest and confirmed their participation in this demonstration project. Eleven national reports have been received within the time frame of the project. The demonstration completed with an overall positive feedback for the participating organisations. Most of the participants concluded that JRODOS would be the version of RODOS that will be used in future in their emergency centres. However, some recommendations should still be considered. In this way, this demonstration highlighted the positive feedback of the users' involvement from the beginning of the RTD project and via the demonstration up to the final product.

3. RODOS users group (RUG)

The objective of the RUG during the EURANOS project was to provide RODOS system users with assurances that their experience and their demands are adequately considered. The aim was also to assure that there is a long lasting commitment of the RODOS developers to ensure proper operation and maintenance of the system for the future. To stimulate the feedback expected from the RUG, a strong interaction with the demonstration activities within EURANOS project had been established.

Specific aims of the RUG include:

- to provide a platform through which the members of the RUG can communicate their views, needs and comments and exchange their experience related with all elements of the RODOS system and its use, in particular provide response and guidance on refinements to make the system more user friendly and for any future developments of RODOS;
- to contribute to, to discuss and to approve the evaluation reports of the individual demonstration projects;
- to establish reports on RODOS users' requirements and views to the EURANOS Management Committee, and to provide advice on specific questions of the Management Committee, such as on planned directions for improvements / development;
- to share experience gained while integrating RODOS in the national emergency management arrangements, and to enable RUG members to enhance their own arrangements;

- to identify best practices, to share technical know-how and organisational solutions, software developments and data bases and their implementation, and to provide mutual support, particularly on a regional basis;
- to share practice and solutions related with use of RODOS for training and in exercises;
- to provide a forum through which the members of the RUG can network with each other, independent of the RUG's activities;
- to establish contacts to the User Groups of other decision support systems within Europe (ARGOS, Hoe *et al*., 2002; and RECASS, Shershakov *et al*., 1993) and overseas and/or to emergency management organisations not involved in the EURANOS project;
- strive at reaching compatibility of the RODOS system with other decision support systems;
- to ensure sustainability of the RODOS decision support system after the end of the EURANOS project through the establishment of maintenance procedures and sustainable arrangements between the users and the developers;
- promote the use of RODOS in Europe.

To meet the objectives set out above, the following activities were envisaged for the RUG within EURANOS project:

- to organise and host meetings of the members of the RUG, at least once per year, for discussing and sharing information on different items, such as
  - to implement, operate and apply the RODOS system in the members' organisations;
  - to evaluate demonstration activities performed in the time period after the past meeting;
  - to provide feedback on weak points, mistakes, deficiencies and further improvements based on the experience gained during operation and application of the RODOS system in tests, exercises and training;
  - to identify problems and needs of individual members and to look for solutions;
- to initiate the improvement, modification and further development of RODOS software, but also to provide feedback on documents describing planned software modifications, extensions or supplementary developments, and help identify organisations and/or persons for scientific reviews;
- to provide advice and support in organising and performing demonstration and exercises with RODOS, including national, regional and international exercises;
- to interface with other User Groups and organisations developing or operating decision support systems for off-site emergency management other than RODOS (*e.g*. ARGOS).

The experiences of the RUG have led to significant modifications of the work programme of the EURANOS project. In particular the user interaction with the RODOS system was a key concern of the RUG. In parallel to work packages defined at the beginning of the EURANOS project, a development process has been initiated by the RUG, which consists of following two steps.

In a first step a newly structured user interface was developed using state of the art IT technologies with its implementation in JAVA (object oriented programming language). This new interface facilitates direct error management of the user's input and guides him through a series of easy to understand input frames.

In a second step the existing system was carefully examined and user requirements for further developments were collected. Based on these results a complete re-engineering of the RODOS system has been initiated, focusing on modern IT-technology and enhancing the system to be used as an information platform for tools related to emergency management and rehabilitation.

The RODOS users laid down their requirements for the re-engineering of the RODOS system in a long "wish list", in which priorities for the various requirements were provided, general demands were listed and more detailed requests were developed for a list of 16 use cases, which describe typical applications of the system in an emergency centre. Especially important for the RUG were the following topics to be considered in the re-engineering:

- user friendly and intuitive graphical user interface with low training requirements and easy, consistent and neatly arranged user input forms;
- graphical representation of results that meets user requirements (*e.g.* integration of state-of-the-art GIS subsystem supporting common GIS standards, multi-lingual, annotated, etc.);
- easy system administration and low maintenance costs;
- the system should be cross-platform with running on Windows, Linux, possibly MacOS;
- technical support including hot-line, web page (properly managed, supervised and kept actual, with notification on news etc.) for download both updates, patches, new versions etc. and guides and manuals, FAQ section;
- easy way of integrating external simulation modules in a framework with clearly defined interfaces.

In the framework of the re-engineering of RODOS many prototypes were issued for testing. The delivered prototypes were immediately evaluated by the RUG. Following this evaluation, the RUG provided guidance in defining the objectives of the next prototype. This interaction was the only guarantee, that the re-engineering would achieve what the operational community expected.

4. Conclusions

Work carried out during the EURANOS project was demonstrated successful through the demonstration projects, which were the focal point for all application oriented RTD activities. The demonstrations and the intensive interaction with the end-users organised in the RUG has led to significant modifications of the working programme from the beginning of the project. They initiated in particular the development of the user friendly input interface RODOS-Lite and the complete re-engineering of the RODOS system focusing on modern IT-technology and enhancing the system to be used as an information platform for tools related to emergency management and rehabilitation. The integration of the end user via all possible means was the key of the success of the EURANOS project.

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