EUROPEAN COMMISSION

5th EURATOM FRAMEWORK PROGRAMME 1998-2002
KEY ACTION : NUCLEAR FISSION

LearnSafe

LEARNING ORGANISATIONS FOR NUCLEAR SAFETY

CONTRACT N° FIKS-CT-2001-00162

Deliverable 3: Methods and Tools for Data Collection during Phase 1. 17.2.2003

Summary: The deliverable describes the data collection methods and tools that have been and are going to be used in the first empirical phase of the project. It also includes a description of how the collected data will be analysed. The deliverable completes the workpackage WP1 of the project.

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1 INTRODUCTION

The LearnSafe project has been divided into two major phases of theoretical and empirical investigations. The first phase is devoted to *management of change* in the belief that the adaptation to changed environmental conditions provides one of the major challenges to nuclear power plants today. The second phase is devoted to *organisational learning,* which is seen as an important process in the pursuit of continued improvement of performance measured in terms of both safety and efficiency.

The present report has been written as a part of the workpackage 1 to describe the underlying methodology and tools that participants used during data collection in the first phase of the project.

2 RESEARCH QUESTIONS

A number of research questions were identified and developed to guide the LearnSafe research team in their search for relevant methodologies.

Phase 1 – Management of Change

The first phase of the project was devoted to the *management of change* in recognition that various mechanisms of change bring new challenges to the senior management of nuclear power plants. This led to the formulation of the following research questions:

Q1: What are the perceived emerging challenges in the management of nuclear power plants?

Q2: How do senior managers cope with emerging challenges in the management of nuclear power plants?

Q3: What improvements could be made in respect to coping with emerging challenges in the management of nuclear power plants?

Phase 2 – Organisational Learning

The second phase of the project is connected to the concept of *learning organisations*. A considerable amount of research within the organisational and management sciences has been devoted to investigating how learning occurs and what characteristics facilitate organisational learning. It is therefore the intention that results obtained during the first phase of the project will be reviewed in the light of this research in order to refine the research questions for phase 2 of the project. The following preliminary considerations can however already at this stage give some indications for the direction of the research during the second phase of the project:

Q4: What kind of features and attributes characterise learning organisations?

Q5: What are the most common barriers to organisational learning and how can they be removed?

Q6: How are various company cultures and sub-cultures influencing organisational learning?

3 METHODS AND TOOLS FOR RESEARCH QUESTION Q1

Q1: What are the perceived emerging challenges in the management of nuclear power plants in the context of safety?

The LearnSafe research team selected several methods to be utilised to answer research question Q1. Technically this approach is referred to as triangulation i.e. the approach encompasses the use of a number of methods of data collection to improve the effectiveness of a particular study. The target groups and the chosen methods are illustrated in Figure 1.

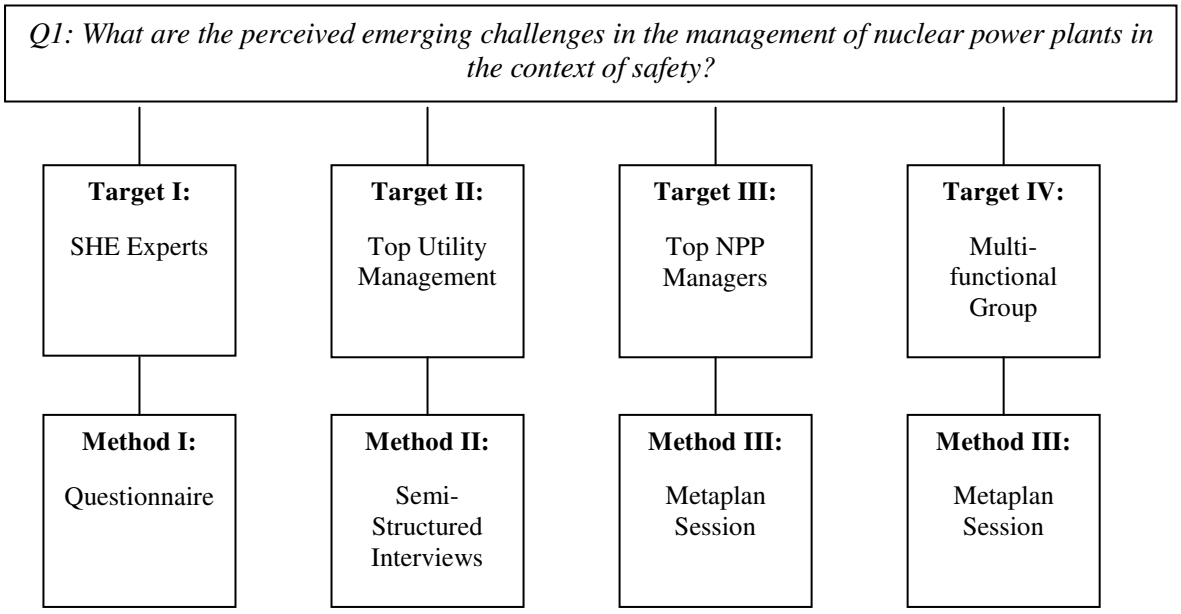


Figure 1. Methods utilised for answering the research question Q1 of the LearnSafe project

3.1 Target Group I – Method I

Safety, Health and Environmental professionals were selected using an opportunity sampling method, to become part of an expert group. The majority of these experts either worked within functional teams within the partner organisations or directly within the individual power plants. Additional members of the expert group were nuclear safety researchers, who had an in depth knowledge of the sector. Questionnaires were used to gather data from the expert group. Two questionnaires were designed by members of the LearnSafe research team using a list of challenges that had been generated from past research (cf. Appendix 1). The questionnaires were distributed to the groups of experts in each of the participating countries, completed and then returned to the LearnSafe research team. The questionnaires were utilised to gather data in relation to the urgency (current challenges: 0-5 years, intermediate challenges: 5-10 years, future challenges: +10 years) and importance (extremely important, very important, fairly important, neither important or unimportant, fairly unimportant, very unimportant, extremely unimportant) of challenges faced by the management of nuclear power plants. (See Appendix 2 for further details of the procedure used).

3.2 Target Group II – Method II

During the next stage in the data collection process interviews were conducted with top utility management within each of the participating countries. The group of top utility managers included managing directors and station managers. Semi-structured interviews were used to gather data from this target group; such a method was selected as it was felt that structured interviews would limit the quality of data gathered, whilst the use of non structured interviews would limit comparability between the LearnSafe partners. The main interview question elaborated research question Q1; the interviewee was asked to talk freely around this question and were then asked to share their thoughts on each of the challenges generated by the LearnSafe research team from past research (see Appendix 5 for further details of the procedure used). Detailed interview notes were taken during the course of the interview; when the interview notes had been written up they were forwarded on to the interviewee; this process acted both as an accuracy check as well as giving the interviewee an opportunity for further comment. In Finland and Sweden interviews were taped and then transcribed. A summary of the interviews was then presented to the top managers for their comments.

3.3 Target Group III – Method III

The next target group that was identified for participation during the data collection phase of research question Q1 was senior nuclear power plant management. This particular group was made up of approximately 10 senior nuclear power plant managers (level 1 and level 2). Senior nuclear power plant managers were invited to participate in a Metaplan session, which was designed to create an opportunity for mapping the challenges. The Metaplan technique was developed to encourage individual involvement by all participants, it also facilitates group interactions and discussion. Metaplan is an active data collection technique during which the researcher acts as a moderator to the process and guides the group through the discussion. The researcher ensures that all participants are given the opportunity to share their opinions and takes notes of the discussions between the members of the group.

At the end of the session participants are asked to indicate the three most important challenges and in some countries a digital photograph is taken of the map of challenges (see Appendix 6 for further details of the procedure used).

3.4 Target Group IV – Method III

The Metaplan methodology was also used with a multi-functional group selected from within the participating nuclear power plants. Approximately 10 multi-functional group members were selected from various departments within the nuclear power plants to take part in the session; the groups consisted of individuals from Operation, Maintenance, Technical, Quality/ Safety, Training, Chemistry and Human Resource Management. (See Appendix 6 for further details of the procedure used).

3.5 Data analysis

Once the data collection phase was completed the LearnSafe partners entered the data analysis phase. To ensure a full utilisation of the data several complementary data analysis methods were used. The expert data gathered via questionnaires was the most straightforward and it was fed into standard statistics package for social sciences (SPSS) and analysed. Researchers

also produced descriptive statistics, frequency data and histograms portraying similarities and differences between data sets.

The Metaplan data and the data collected in interviews provided a larger challenge. The interview data was reduced to form short summary statements of each of the challenges identified during the interviews, which were integrated with the data collected in the Metaplan sessions. Two methods, Content Analysis and a coding of the data using fuzzy sets will be used for further analysis of this data.

The Content Analysis method as described in Appendix 7, involves the definition of key words and phrases, from the interview and Metaplan transcripts, being listed, counted and categorised. Content Analysis of data allows researchers to generate frequencies from the qualitative data, whilst maintaining the richness of the data together with a qualitative commentary of the data to accompany the content analysis data matrix.

The interview and the Metaplan data will also be analysed using a method relying on fuzzy sets (cf. Appendix 8). This method involves the classification of the membership of the challenges in a small number of fuzzy sets, which are defined by an underlying model of management tasks. Three independent coding exercises are expected using a standardised set of instructions to allow for an assessment of the coding reliability.

In comparing the two selected approaches it can be noted that they have much in common. It will therefore be interesting to note possible similarities and differences in the interpretation of the data they may generate.

4 METHODS AND TOOLS FOR RESEARCH QUESTION Q2

Q2: How do senior managers cope with emerging challenges in the management of nuclear power plants?

In responding to the research question Q2 case stories will be collected from the participating nuclear power plants. A case story is in this context understood to be a comprehensive description of strategies and approached for coping with challenges that are seen at the plants. The case story is explicitly intended to address the most important challenges identified in the analysis of the data collected for the research question Q1 in order to gather data related to coping strategies utilised to deal with them. A case story from a specific plant is expected to reflect actions and plans, which are discussed and initiated by the senior management group. It is intended that a case story should also address the time frame of actions and plans, together with an assessment of likely and less likely development trends in the future. To the extent possible it would also be interesting to identify possible hurdles and concerns that are taken into account and responded to in actions and plans.

Depending on the availability of people at the nuclear power plants slightly different methods may be used in the collection of background data and in the finalisation of the case story. One possibility is to gather a team of nuclear power plant senior managers and present the analysed responses to the research question Q1. The senior managers would then be asked to work through the challenges in group exercises to identify actions and plans by which they have or are going to respond to the challenges. Guidance for the group exercise is found in Appendix 9.

If there are difficulties in finding the time for a group exercise the case story could also be built through a set of open-ended questions that are distributed to a suitably selected group of

people at the nuclear power plant. The set of questions in Appendix 9 is intended to support the development of specific questionnaires by the national LearnSafe research teams in the understanding that the availability of people at the nuclear power plants may raise the need for variations in the procedure. The questionnaire should ask selected individuals within the participating nuclear power plants to explain how they view the challenges and how they cope with each of them. Responses are recorded and they are used to build a draft of the case story. This draft is then used in interviews for further reflection on actions and plans used at the nuclear power plant for coping with the challenges.

5 METHODS AND TOOLS FOR RESEARCH QUESTION Q3

Q3: What improvements could be made in respect to coping with emerging challenges in the management of nuclear power plants?

This research question can be broken down into more detailed questions as indicated in Appendix 10. The research question Q3 will be approached in three different ways:

1. During the data collection sessions for research question Q2 opportunities may arise to address research question.
2. A web-based "chat room" will be established and supported to facilitate interactions between research partners to stimulate a virtual brainstorming exercise. The inputs to the chat room will be analysed to provide a database of ideas for improvements.
3. The mid-term seminar[1] will be used not only as a reporting event, but also as a brainstorming exercise in group discussions to generate further ideas.

The "chat room" facility will be integrated in the closed web-site of LearnSafe and it will be facilitated by the project manager. It is intended to provide senior managers with a forum for discussion of the projects findings to date as well as encouraging the sharing of experience and knowledge of coping with the challenges that have been identified. Through use of this "chat room" senior managers can learn of ways their colleagues have used to cope with various challenges.

The LearnSafe mid-term seminar was originally intended to be open also for outsiders. The inclusion of the seminar as one important part in the data collection of the first phase of the project has however made this impossible. On the other hand the closedness of the seminar provides better opportunities open discussions. The participation in the LearnSafe mid-term seminar will be on invitation only and it is expected that by average each partner will be represented by two persons. Partners will appoint their representatives to the seminar in due course.

[1] Preliminary dates are set to 22-23 May 2003 and the venue selected is the offices of WANO Paris Centre.

APPENDIX 1. LEARNSAFE LIST OF CHALLENGES

The following list of challenges was generated in the LearnSafe project to support the data collection in the first phase of the project. The list has been slightly extended in later phases of the data collection. The list of challenges has been translated to the native languages of the LearnSafe partners.

Ageing of Personnel/ generation shift/ preservation of competence.	Public opinion.	Ageing components.
Contractors (availability, skills and competency).	Mergers and Acquisitions.	Decommissioning.
Difficulties in recruiting young people.	Subcontractors/ contractors: cancellation and monopolisation.	Terrorism/ sabotage.
De-motivation of personnel.	Deregulation/ competition.	Difficulties to proceed with programmes for waste storage.
Premature closing of plants due to difficulties to compete with electricity prices.	Increasing importance of soft human and organisational factors and adaptation.	Uncoordinated regulatory actions in nuclear safety, labour safety, environmental protection, etc.
New methods and principles of regulation.	Constraints to reduce costs: shorter outage/ corporate influence/ dismissals.	Utilisation of information and telecommunication technologies.
Floods of Paperwork.	Distrust in authorities: national and international.	Increase in specialisation.
Globalisation of perception of events	Increasing dependence	Difficulty in maintaining competency in specialised nuclear fields.

APPENDIX 2. MATERIALS AND PROCEDURE FOR THE EXPERT GROUP

Materials:

- List of challenges generated by the LearnSafe team.
- Exercise 1.
- Exercise 2.

Procedure:

1. Open the session with a brief introduction to the project and an outline to the procedure:

   Welcome and thank you for attending this session. The project we are engaging in will explore the management of change and organisational learning within the nuclear sector. We are hoping to collect data from senior managers within the nuclear power plants participating in the investigation to provide practical support in their managerial tasks in relation to plant safety. The research is funded by the European Commission as part of the Euratom research and training programme 5th framework. It is an international project consisting of fourteen partners from five countries, which includes Finland, Germany, United Kingdom, Sweden and Spain.

   At this stage of the project we are seeking to generate a preliminary list of the developing challenges faced in the management of nuclear power plants in the context of safety and as such we would like you to identify as many of the challenges you can. All data gathered during the course of the investigation will remain anonymous.

2. Present the Expert group with the list of challenges generated by the LearnSafe team.
   - Do the Experts agree with the challenges that have been identified on the list? Ask the Experts to assess the list and make their comments.
   - Have the Experts identified any additional challenges? Make a note of any suggestions.
3. Ask the Experts to prioritise the challenges that have been identified in terms of time-scale please refer to Exercise 1 (cf. Appendix 3).
4. Ask the Experts to prioritise the challenges that have been identified in terms of importance please refer to Exercise 2 (cf. Appendix 4).
5. Explain that all of the challenges identified will be collated through the project leader VTT of Finland.
6. Finally, thank the Experts for their participation in the session.

APPENDIX 3. EXPERT GROUP EXERCISE 1: IDENTIFYING THE URGENCY OF CHALLENGES

Please prioritise the following list of challenges in terms of their immediacy by placing a cross in the appropriate box.

Challenges for the Nuclear Industry.	Current Challenges (0 - 5 years)	Intermediate Challenges (5 - 10 years)	Future Challenges (+ 10 years)
Ageing of Personnel/ generation shift/ preservation of competence.			
Contractors (availability, skills and competency).			
Difficulties in recruiting young people.			
De-motivation of personnel.			
Premature closing of plants due to difficulties to compete with electricity prices.			
New methods and principles of regulation.			
Floods of Paperwork.			
Globalisation of perception of events			
Public opinion.			
Mergers and Acquisitions.			
Subcontractors/ contractors: cancellation and monopolisation.			
Deregulation/ competition.			
Increasing importance of soft human and organisational factors and adaptation.			
Constraints to reduce costs: shorter outage/ corporate influence/ dismissals.			
Distrust in authorities: national and international.			
Ageing components.			
Decommissioning.			
Terrorism/ sabotage.			

Challenges for the Nuclear Industry.	Current Challenges (0 - 5 years)	Intermediate Challenges (5 - 10 years)	Future Challenges (+ 10 years)
Difficulties to proceed with programmes for waste storage.			
Uncoordinated regulatory actions in nuclear safety, labour safety, environmental protection, etc.			
Utilisation of information and telecommunication technologies.			
Increase in specialisation.			
Difficulty in maintaining competency in specialised nuclear fields.			

Thank you for your time.

Please feel free to add any additional comments in the space provided:

APPENDIX 4. EXPERT GROUP EXERCISE 2: IDENTIFYING THE IMPORTANCE OF CHALLENGES

Please prioritise the following list of challenges in terms of their importance by placing a cross in the appropriate box.

Challenges for the Nuclear Industry.	Extremely Important	Very Important	Fairly Important	Neither Important or Unimportant	Fairly Unimportant	Very Unimportant	Extremely Unimportant
Ageing of Personnel/ generation shift/ preservation of competence.							
Contractors (availability, skills and competency).							
Difficulties in recruiting young people.							
De-motivation of personnel.							
Premature closing of plants due to difficulties to compete with electricity prices.							
New methods and principles of regulation.							
Floods of Paperwork.							
Globalisation of perception of events							
Public opinion.							
Mergers and Acquisitions.							
Subcontractors/ contractors: cancellation and monopolisation.							
Deregulation/ competition.							
Increasing importance of soft human and organisational factors and adaptation.							

Challenges for the Nuclear Industry.	Extremely Important	Very Important	Fairly Important	Neither Important or Unimportant	Fairly Unimportant	Very Unimportant	Extremely Unimportant
Constraints to reduce costs: shorter outage/ corporate influence/ dismissals.							
Distrust in authorities: national and international.							
Ageing components.							
Decommissioning.							
Terrorism/ sabotage.							
Difficulties to proceed with programmes for waste storage.							
Uncoordinated regulatory actions in nuclear safety, labour safety, environmental protection, etc.							
Utilisation of information and telecommunication technologies.							
Increase in specialisation.							
Difficulty in maintaining competency in specialised nuclear fields.							

Thank you for your time.

Please feel free to add any additional comments in the space provided.

APPENDIX 5. UTILITY TOP MANAGERS SEMI-STRUCTURED INTERVIEW SCHEDULE

Send in advance a short description of the LearnSafe project, the intent of the session and the main questions to be discussed.

I would like to take this opportunity to thank you for attending this interview. The current project has been developed in consultation with industrial partners (identify own industrial partner at this stage) to explore the management of change and organisational learning in relation to safety within the nuclear sector. The research is funded by the European Commission as part of the Euratom research and training programme 5th framework. It is an international project consisting of fourteen partners from five countries.

During the interview I will be asking you a series of questions, please feel free to add any additional comments and discuss any further issues that have not been covered. All data gathered within the investigation will remain anonymous. Do you have any further questions?

1. Gaining background information on each of the participants.

   Tell me a little of your own background and career.

2. Gathering information about challenges in the nuclear industry.

   Could you please give your views on the general situation in the nuclear industry and the major challenges that are facing the nuclear power plants on a medium term?

3. Gathering information about the challenges identified earlier.

   The following list of challenges (without any specific order) has emerged in the LearnSafe project in discussions among the partners and representatives of the participating nuclear power plants. Please consider this list as an initiator of further discussions.

   We have already discussed many of these challenges, but would you like to lift up any of these challenges and give further comments? (Please note that some of the items on the list may not be recognisable as a challenge in your country).

4. Identifying further challenges.

   In our discussion we have gone through many different challenges are there any challenges which have not been touched on? Could you please comment on that?

5. Additional comments (if time allows)

   If I understood correctly, one of the major challenges as you see it is ... . How should one approach this challenge and what further challenges could this approach generate?

APPENDIX 6. MATERIALS AND PROCEDURE FOR THE METAPLAN SESSIONS

Materials:

- Large board.
- Large sheet of paper to record the research question.
- Small rectangular cards to record individual contributions to the discussion.
- Large rectangular cards to record cluster headings.
- List of challenges identified by target group I and II.
- Blue-tack.
- Markers pens (x15 black, x2 red, x2 green).
- Digital Camera

Procedure:

1. Before the participants arrive prepare the room. Ensure that there is a large board at the front of the room, a large table and enough chairs for all participants. Once the room has been prepared ask the participants to enter the room.

2. Once all of the participants have arrived and are seated begin the session with a brief introduction of yourself and the project:

   I would like to take this opportunity to thank you for attending this session. The current project has been developed to explore the management of change and organisational learning in relation to safety within the nuclear sector. The research is funded by the European Commission as part of the Euratom research and training programme 5th framework. It is an international project consisting of fourteen partners from five countries (hand out project information sheet).

3. Encourage group members to take part in an 'ice-breaker' introduction, which will facilitate gaining background information on each of the participants. (The participants may already know each other but may not know the facilitator).

4. Introduce the topic of discussion for the session with a brief explanation to put it into context. Write clearly on one of the large sheets of paper research question Q1 (this can be done before the session begins) and attach it to the board at the front of the room.

   What are the perceived developing challenges (medium-term 3-5 years) in the management of your nuclear power plant in the context of safety?

5. Begin by handing out to each of the participants four small rectangular cards and a black marker pen. Ask each individual to think of four emerging challenges in the management of their nuclear power plants and record their answers clearly on the cards provided (one word answers are better).

6. After allowing a few minutes for writing collect the cards from each member of the group. Shuffle the cards and then proceed by reading each of the cards one by one. As each card is read stick it to the board in a random order.

7. After each card has been read and stuck to the board ask the group to sort each of the challenges by content, to create clusters of cards with the same or similar meaning. Encourage

participants to interact with each other and the board. *During this procedure any objections or questions can be recorded on small rectangular card in red pen and stuck next to the original contribution* (this is an optional addition.)

8. Once participants have finished sorting the cards ask them to circle each of the clusters using the marker pens. Finally ask the group to find a title for each of the clusters that is able to encompass all contributions within the particular cluster. Record the titles on large rectangular sheets of paper and stick them on the board above the particular cluster.
9. Take a photograph of the pin board using the digital camera.
10. Present the group with any alternative challenges generated from target group I and II. Read aloud each of the challenges from the list and ask the group to react to each of the newly presented challenges either by integrating them to the original Metaplan or by refusing them (write any new challenges on small rectangular cards in greed pen).
11. Take a photograph of the pin board using the digital camera.
12. Number each of the clusters/ challenges that appear on the Metaplan. Present each of the participants with a piece of paper and ask each individual to indicate on the piece of paper which three of the challenges they feel are the most important overall.
13. Collect each piece of paper from the participants.
14. Give the participants some feedback (Group discussion of the challenges that have been identified.) Thank the participants for their time.
15. Document the session using the Moderators Diary.

APPENDIX 7. CONTENT ANALYSIS

The main difficulty in analysing data consisting of sentences expressed in natural language is connected to the ambiguity in the use of words. This problem is well known in the behavioural sciences and it has been addressed by many prominent scholars. The main issue in this connection is to understand the basic meaning of the expressions and to put them into context to be analysed together with similar expressions. The data collected in the LearnSafe project in the Metaplan sessions and the interviews is typical in this regard.

It is therefore to be expected that there is much conflict surrounding the definition and use of content analysis within research in behavioural sciences. One important view can be captured in the citation "Content analysis is a phase of information processing in which communication content is transformed, through objective and systematic application of categorisation rules, into data that can be summarised and compared".[2]

Content analysis is most frequently used to describe attributes of messages, without reference to either the intentions of the sender or the effect of the message upon those to whom it is directed.[3] Using content analysis hypotheses may be tested by comparing the messages produced by two or more different sources.

The benefit of Content Analysis is that it allows researchers to generate frequencies from qualitative data, whilst maintaining the richness of the data. The method involves the generation of key words and phrases, from the Metaplan and the interview transcripts being listed, counted and categorised.

LearnSafe researchers will use computer assisted qualitative data analysis software to carry out the content analysis. N-Vivo 2 has been selected for use by the research team, as it is better at supporting social science research than other packages that are available. N-Vivo 2 encourages an exploratory approach to data analysis and is better at fine-grained analysis than other data analysis software.

It is important to recognise that although computer assisted qualitative and quantitative analysis share the same term, analysis, the computer supports the analysis in very different ways. In the case of quantitative analysis, using statistics it is the computer that does most of the hard work i.e. the calculations and creation of statistics. In the case of qualitative analysis there is no real equivalent to the calculation of statistics, though most programs produce simple counts. The real heart of the analysis requires an understanding of the meaning of the texts, and this is something that computers are still a long way off.[4]

N-Vivo 2.0 has been designed to support the researcher in the exploration and analysis of qualitative data and as such it has a number of useful functions. The researcher begins the qualitative analysis of the data by importing the data transcripts into the computer package; using N-Vivo 2.0 the researcher can then browse and explore the documents during the analy-

[2] Paisley, W.J. (1969) studying 'style' as deviation from encoding norms. In Gerbner, G. Holsti, O.R. Krippendorff, K. Paisley, W.J. and Stone, P.J. (Eds.) The analysis of communication content: development in scientific theories and computer techniques. New York: Wiley.

[3] Holsti, O.R. (1969). Content Analysis for the Social Sciences and Humanities. Addison-Wesley, Reading, MA.

[4] Gibbs, G. (2002) Qualitative Data Analysis: Explorations with N-Vivo. Open University Press: Buckingham/ Philadelphia.

sis. Nodes are used by N-Vivo 2.0 as a container for categories and codes. Nodes can represent concepts, processes, people, abstract ideas, places and any other categories within the project. When the researcher codes the data, the references to the text are stored in specific nodes. Qualitative categories can be created ‘up’ from the data, as meanings are discovered, as well as being created ‘down’ from prior ideas and theories.

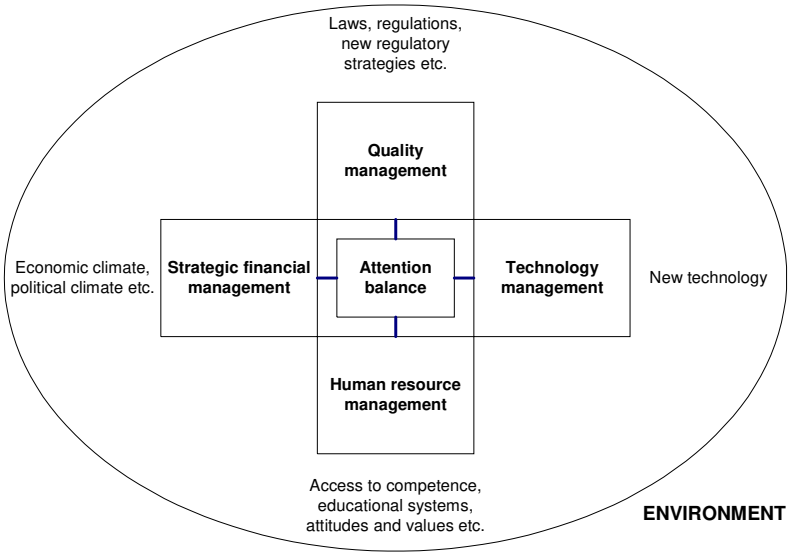
N-Vivo 2.0 utilises attributes to store information related to the data sources, the people, the organisations and any other aspect of interest within the study. Attributes are integrated with all filtering and searching procedures. Coding is used as a method of bringing together data and ideas. N-Vivo 2.0 codes the data by collecting references to material about a topic at nodes so that it can be retrieved and reported. N-Vivo 2.0 has been designed to support many modes of coding and integrate them with other ways of viewing and dissecting, linking and gathering material. Sets and index design trees are complementary methods of shaping data, which allow the researcher to manage the data analysis process. N-Vivo 2.0 also has integrated search processes for exploring coding, text, attributes and combinations of these. The outcome of the analysis will be a written report of the findings, which will include a visualisation of the challenges and their relationships.

APPENDIX 8. CODING OF PERCEPTIONS USING FUZZY SETS

The method described below has been developed to enable a computerised handling of the data collected in the Metaplan sessions and the interviews. The method is based on two assumptions:

1. The challenges are expressions of perceived difficulties in handling certain issues that are connected to organisation and management.
2. The issues can be represented by a common underlying model of functional areas that have to be attended to by the senior management at the nuclear power plants.

This implies that when the underlying model is selected the challenges can be represented by their membership in the fuzzy sets as characterised by the main concepts of the model. The model[5] selected for the purpose of coding the challenges is described in the following figure.



This model is interpreted to address the following five basic concepts (or dimensions):

1. Economic and financial issues (strategic financial management).
2. Workforce and competence issues (human resource management).
3. Technology issues (technology management).
4. Systems and procedures issues (quality management).
5. Environment issues (monitoring and adapting to changes in the environment).

These five issues or dimensions are interpreted as fuzzy sets in which each of the challenges has a certain membership. Membership only in one of the fuzzy sets would indicate that the challenge has a very clear focus in that functional area. Similarly a challenge that has high

[5] Carl Rollenhagen (2002). Safety Management of Nuclear Power Plants: Values and balance of attention, LS_rP001.doc, available at the LearnSafe external web-site http://proxnet.vtt.fi/learnsafe/.

loading on two or more of the dimensions would indicate that managers in coping with the challenge would need to find a proper balance between the areas.

This means that the challenges are coded according to their perceived membership into the five classes above. As a practical procedure the degree of membership in each of the five fuzzy sets were assessed on a scale of 0 to 100 points. 100 points denote a very strong membership while 0 denotes no membership. A further description of the five fuzzy sets can be given in the following way:

- *Economic and financial.* A challenge that to some extent is connected to the scarcity of financial resources or to the definition of proper cost-effective solutions to problems of large economic importance should load this dimension.

- *Workforce and competence.* Challenges that are concerned with workforce or competence related issues at the nuclear power plant. Challenges such as the age structure of the personnel and possible difficulties of ensuring a good job motivation should also load this dimension. The workforce is in this connection to be interpreted in a broad sense, including also contractors working on the plant site.

- *Technology.* A challenge that in one way or another are connected to the design, implementation or use of technologies (old and new), that are crucial for a continued high performance of the nuclear power plant. This dimension is also assumed to cover the management of ageing equipment.

- *Systems and procedures.* A challenge that is concerned with formal as well as informal ways of structuring tasks, roles and responsibilities at the nuclear power plant. It therefore covers general practices for both regular day-to-day operations and more seldom executed tasks. It is also assumed to cover written procedures and quality systems as well as reward and punishment systems.

- *Environment.* Challenges that are related to external issues over which the plant management/ organisation has no direct control. This dimension includes, for example, regulatory requirements, economic trends in the society, public acceptance of nuclear power, expectations of young people towards the industry, political climate, etc.

According to another interpretation, the coding can be seen as a way to establish a distance relation on the set of challenges. This distance relation enables a clustering of the challenges in a five-dimensional space. In this clustering it is expected that the need for maintaining balances between the basic dimensions will show up as clusters with large loading on two or more of the five dimensions. The distance relationship makes it possible to order the original data in a way that makes more sense to the analyst than a pure random order.

The intention is to use standard statistical analysis packages to do a clustering of the whole material. By introducing additional variables connected to countries, to plants and to the source of information (top managers, senior management group, multi-functional managers) it is expected that differences in views can be detected. The clusters generated from the whole data set also makes it possible to do a comparison with the clusters as generated at the individual Metaplan sessions. Because there is a one-to-one relationship between the challenges in the data set and the cards written during the Metaplan sessions, the number of data points within each cluster also provides important information, which can be compared to the available evaluation of the importance of clusters and challenges as collected during the sessions.

As a comparison with the Content Analysis method as described in the Appendix 7, it should be noted that the final outcome of the analysis is not expected to differ very much. The main methodological difference between the two methods is the fuzzy set method relies on an a priori explicit model that is assumed to explain the collected data.

APPENDIX 9. PROCEDURE FOR COLLECTION OF CASE STORIES

It has been decided that the research question

> *Q2: How do senior managers cope with emerging challenges in the management of nuclear power plants?*

will be approached through the collection of case stories. A case story is assumed to be a comprehensive description of strategies and approaches as applied or planned as responses to a given set of challenges. This set of challenges has been obtained through the analysis of the data as described in Appendices 7 and 8. It is in this connection important to note that a case story should not consist of opinions, but facts on how the plant has responded or plans to respond to the challenges. A case story may if considered feasible be broken down into parts in which each of the challenges is addressed separately. A case story may also be structured according to organisational functions that are given the responsibility for implementing actions or plans. The collection of background data for the case story can be carried out in slightly different ways depending on the availability of people at the nuclear power plants.

Below is a set of questions, which should be used to create the specific questions to be answered in writing of case story. The more specific questions can be written as questionnaire or they can be used to structure interviews. In the creation of the case story the questions are not intended to be answered literally, but the list of questions are more intended to initiate a discussion. In the creation of the case stories it would be important also give background and the pondering behind the answers. Whenever possible it would be desirable to indicate possible strengths and weaknesses with specific strategies. It would also be valuable to document possible experiences (good/bad) in connection with the strategies.

The table below is intended to stimulate the creation of more specific questions to be asked when the analysis effort to identify the most important challenges has been completed. The assumption is thus that each of the selected challenges will be described and characterised in a short paragraph, which will be followed by more concrete questions.

Aspects of the challenge	**Questions to be asked**
Relationships	Is this challenge related to some other challenge? In what way is it related?
Urgency and timing	How urgent are you viewing this challenge to be? In which time frame are you responding to the challenge?
Applicability and responses	Has this challenge been discussed at your plant? How have you responded to the challenge?
Actions and plans	Please describe actions and plans in some detail (goals, responsibilities, resources, time-schedule, milestones, etc.).
Constraints	How are your actions and plans constrained? How would actions and plans change if constraints were removed?
Hurdles and concerns	Are there hurdles or concerns in the actions and plans? How are you monitoring upcoming problems? How can the success of the actions and plans be followed?

Aspects of the challenge	Questions to be asked
Strategies applied at other nuclear power plants	Do you know of such strategies? Are these strategies familiar? Have they been discussed at your plant? What have the responses been?
Other issues	Important questions that were not asked? Any questions of your own?

Whenever it is possible to collect a group of senior managers for a joint discussion this opportunity should be used. The following suggestion for the conduct of such a session is indicative and may be varied according to circumstances.

1. Researchers will present the analysis of the challenges collected during the Metaplan sessions and interviews.
2. The challenges collected at the nuclear power plant in consideration and its corresponding top managers are reflected in comparison with the international material.
3. Participants split up into teams and are assigned challenges to work through. Groups are asked to describe a scenario likely to happen with corresponding actions and plans to be undertaken. In recognition of the fact that most actions and plans are constrained in some way or another it would be interesting also to hear the participants view of how the actions and plans would change if these constraints were removed.
4. Results are presented to the group and discussed.
5. Results from the sessions will be condensed and put into the LearnSafe chat room

APPENDIX 10. QUESTIONS FOR THE DATA COLLECTION FOR THE RESEARCH QUESTION Q3

The research question

> *Q3: What improvements could be made in respect to coping with emerging challenges in the management of nuclear power plants?*

is the final research question of the first phase of the LearnSafe project. This question asks for various ideas for actions that can be initiated to help the nuclear power plants in their process of adaptation to changes in their operational environment. Answers to the question may be related to new and innovative approaches in coping with some of the challenges or they may be improvements of presently adopted strategies. In responding to the question it would also be important not only to identify improvements, but also actors that should be involved and how actions can be brought forward.

More specifically the collection of responses to the research questions would involve the listing of good ideas together with answers to questions as below.

Areas to be addressed	**Questions to be asked**
Characteristics	How can the idea be described – new method, model or tool, – improvement of existing methods, models or tools, – new way to organise work, – new forms of co-operation, – new institution to be created?
Actors	Which parties should be involved – the plants themselves, – company groups, – industrial consortia, – regulator, – academia, – research, – international organisations?
Resources	What kind of resource would be needed – money, – time, – people?
Implementation	What would be the best way to bring the idea forward? How can the necessary resources be found? What should be the first step in the implementation?