1. Introduction

In the last five years, a new generation of training simulators has appeared on the scene. More and more utilities are using non control room replica simulators for their operator training. The Multifunctional Optimised Scope Simulator (MOSS) is one of them. This type of simulator offers a multiplicity of functions that are useful in the field of operator training.

The Multifunctional Simulator is indeed intended to be used:

- for initial training, as "Basic Principle Training Simulator";
- for training on specific systems, as "Functional Simulator";
- for operation training, by offering an environment enabling to implement all operating procedures;
- as an analyser, providing pedagogical screens intended to explain physical phenomena.

As such, it is defined as multifunctional.

Despite the numerous possibilities offered by MOSS, the training of operators in such fields as control room layout, localisation of instrumentation and actuator handling is not satisfactory, as the Man Machine Interface of MOSS is not a control room replica. Therefore, it should be completed by other means, one of which is On the Job Training (OJT).

In our paper, we will discuss the contribution of a MOSS to the training of nuclear power plant operators and we will explain how this tool can be integrated into a training plan including On the Job Training (OJT). We will then analyse to what extent OJT and MOSS based training can be complementary.
2. **Methodology**

The method used to perform such an analysis is based on Systematic Approach to Training. The ultimate objective is to identify training needs and programs, and to define training material. Starting from Job and Task Analysis and associating the required knowledge to the tasks, one can determine the training needs and draw up an appropriate training program to satisfy the needs. This approach will be used to identify the role of MOSS and OJT in the training process and to determine the training fields covered by the combination of those two.

The methodology is illustrated here below:

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Job position
Prescribed and real tasks
Required skill and knowledge
Knowledge already acquired
Additional training required
Knowledge and skill acquisition process
MOSS/OJT complementarity
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3. **Job description and task analysis for the operation personnel**

In performing the Job and Task Analysis we will limit ourselves to the highest level of task and knowledge classification. The detailed list of tasks and knowledge fields are not necessary for the present analysis.

3.1. **Job description**

In this case we will consider the shift supervisor.

As leader of the shift, the shift supervisor is entitled to perform a quality control on all actions taken by the shift members. Therefore in terms of required knowledge he must cover all what is required from the other members of the team. For this reason, the shift supervisor will be considered as the basis for this analysis.

The shift supervisor is responsible for:

- the application of operating instructions in normal and accidental situations;
• the conformity between the plant and the operating technical specifications;

• the application of all measures to be taken to guarantee the safety of the personnel in case of decommissioning or commissioning of any equipment for maintenance or test purposes;

• the quality control of any action taken by any member of the shift by performing, or by giving instruction to perform, double checks required by operating procedures, or by performing sampling controls whenever the double check is not required by the procedures. He is supposed to verify that:
  - any intervention is driven by procedures;
  - all actions recommended by operating procedures are properly applied on time;
  - the action reports are properly written and signed by the appropriate persons.

The shift supervisor has to inform his hierarchy on:

• any event that can alter the safety of the plant and/or the personnel;

• any event that can divert the plant from the operating technical specifications.

The shift supervisor has additional administrative tasks that we do not consider here.
3.2. Task analysis

The task of an operator who controls a process as complex as the one of a nuclear power station may be summarised as follows:

- monitoring the process status evolution;
- taking normal manual action involved in monitoring (including during start-up, shutdown and load transients);
- making a diagnosis regarding malfunctions, including taking action as may be required towards reaching a diagnosis;
- following malfunctions, taking any recovery action (in addition to or instead of existing automatic action) as may be necessary for restoring the process towards a safe status.

The possible sequences of tasks are illustrated below:

For each of these categories the required knowledge and skills can be identified as follows.
4 Tasks and required knowledge and skills

Although specific fields of knowledge and skills can be associated with a specific category of tasks, some of the knowledge fields are common to all categories. They are identified hereafter as generic:

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Knowledge fields and skill</th>
</tr>
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<tbody>
<tr>
<td>Generic</td>
<td>PWR fundamentals</td>
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<tr>
<td></td>
<td>Process systems / equipment, system response and systems interactions</td>
</tr>
<tr>
<td></td>
<td>Control room general layout and localisation of instrumentation</td>
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<tr>
<td></td>
<td>Operating procedures</td>
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<tr>
<td>Monitoring</td>
<td>Steady state values</td>
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<td></td>
<td>Normal operation trends</td>
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<tr>
<td>Normal operation action</td>
<td>Utilisation of actuators</td>
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<tr>
<td>Diagnosis</td>
<td>Relation between trends and possible accidents</td>
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<td></td>
<td>Root cause identification</td>
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<tr>
<td>Recovery actions</td>
<td>Safe shutdown</td>
</tr>
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<td></td>
<td>Critical safety functions</td>
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<td></td>
<td>Recovery action sequences</td>
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</tbody>
</table>

5 MOSS in the knowledge acquisition process

In any learning process four major steps are necessary.

The very basic requirement before starting to learn is the learning need. When the trainee is in the position of expectation his learning potential is significantly higher. These needs are generally associated with individual or collective objectives that are recognised as such. The trainee has to feel that to reach his goals he has to acquire the prescribed knowledge. Once the learning need exists the trainee can start the process of knowledge acquisition.

The knowledge acquisition is, at this stage, a theoretical knowledge. The trainee is just "informed" and has collected a certain amount of information related to the subject. The learning process is far from being achieved. His inclination to forget what he has learned is very high. At this stage he has a certain image of what the real practice would be and most of this image is subject to his own interpretation. These interpretations are associated with uncertainty. Because of these uncertainties, after the knowledge acquisition is achieved, the trainee is willing to receive practical courses. The third stage of the learning process is therefore the practical training.
The main goal of practical training is to give to the trainee the opportunity to replace his expectation of reality by the reality itself. The practical course will enlarge the relation between the knowledge and the trainee. The knowledge is then associated, not only with the theoretical representation of the process but also with actions, visions, and other senses.

Skill building follows the practical training. It consists of the capacity of reacting in almost an intuitive way to any event related to what has been practised long enough.

In this learning process simulators are used in the second and mainly in the third stages. Beside, simulators are more adapted to some knowledge fields. The exercise which follows will consist of analysing the role of the two types of simulator in this learning process in different fields of knowledge:

- **PWR fundamentals, process systems and system interaction**
  MOSS can be used as Basic Principle Training Simulator and its MMI is well adapted to training which is system specific or which deals with systems interaction.

- **Control room layout, localisation of instrumentation, utilisation of actuators**
  The absence of a replica environment is a major problem with MOSS.

- **Operating procedures**
  MOSS can enable major operating procedures to be played, normal operation as well as accident procedures. Since the scope of simulation of the MOSS is optimised some procedures, considered as of minor importance in terms of training, are not simulated.

- **Steady state values, normal operation trends**
  MOSS displays all required steady state values and normal operation trends. The MOSS has, in this case, a definite advantage because it enables to display the parameters in a way that is adapted to training objectives.

- **Relation between trends and accidents, accident root cause identification**
  MOSS offers the possibility of displaying:
  - dedicated pedagogic screens, with parameters associated with a given accident scenario displayed together
  - mainly global internal simulation parameters that are not displayed in a real control room.

- **Recovery actions sequences**
  MOSS is designed to perform all recovery actions.
The following table summarises the contribution of the two types of simulator in terms of training and for the fields of knowledge we have considered.

<table>
<thead>
<tr>
<th>Field of knowledge</th>
<th>MOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWR fundamentals, process systems and system interaction</td>
<td>++</td>
</tr>
<tr>
<td>Control room layout, localisation of instrumentation, actuators handling</td>
<td>-</td>
</tr>
<tr>
<td>Operating procedures</td>
<td>+</td>
</tr>
<tr>
<td>Steady state values, normal operation trends</td>
<td>+</td>
</tr>
<tr>
<td>Relation between trends and accidents, accident sources identification</td>
<td>++</td>
</tr>
<tr>
<td>Recovery actions sequences</td>
<td>+</td>
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6. **Does OJT complete use of non replica simulator in NPP operators training?**

As clearly identified in the above assessment MOSS as all non-replica simulators is not designed to train operators in control room layout, localisation of instrumentation and actuators handling. The question is how far can OJT complete this gap.

In the field of control room layout and localisation of instrumentation it seems obvious that a new operator acting as a shadow of the operating team can learn a lot in a rather short period. Nevertheless two problems remain.

Let us consider that the trainee has learned about the process, the role of the plant systems and their interactions on a non replica simulator. At this very stage he knows and has practised the role of a given component. While observing the "tutor" in action in the real control room he will have to create the link between what he has learned and what he is observing. First of all, if the tutors action is not completed by a verbal explanation the trainee will have a lot of problems to observe each and every action of the tutor. If the tutors gives detailed verbal explanation (considering that he is trained to do so) it will definitely help the trainee to create the above mentioned link but only partially.

As previously indicated the knowledge acquisition process requires not only academic knowledge but also practice. A simple observation in a shadow training, even with detailed verbal explanation will not give to the trainee the opportunity to exercise practically its knowledge. In the specific field of "actuators handling" the problem becomes even more important. The only way to solve this problem is to allow the trainee to handle the actuators himself but by receiving its instruction from a certified operator acting as a tutor.

The major steps to cover during the OJT following the training on a non replica simulator should then be:

- Identification of a qualified and certified operator acting as a tutor
- period of observation by the trainee with verbal explanation by the tutor on each action the tutor is taking

- period during which the trainee is allowed to take actions following the tutor's instructions and under his guidance (the tutor remaining in charge)

Once the trainee has passed his certification exam

- period during which the trainee will be in charge and operate the plant under the supervision of the tutor

Such approach should optimise the most the complementarity between training on non replica simulators and OJT.

7. Conclusion

Considering the cost of full scope full replica simulators, an approach which can integrate a non replica simulator and organise accordingly the OJT can be considered as an interesting alternative to full scope full scale simulators for some utilities. The case of utilities running power plants such as VVER 230 with a rather short remaining life time is a case to be considered.