

## **WP1.2 Guidelines and Methodologies for vocational training in the port sector using simulators**

## **WP1.3 Performance evaluation of simulation-based systems and training actions**

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### SUMMARY

The strategic objective of these guidelines and methodologies is to define a useful and effective methodology to design and evaluate simulation based training for the port sector. In more detail, the main objective is development of a methodology able to analyze organizational and individual training needs, to design a training program with use of simulation devices, and finally to evaluate simulation training program with application of structured but innovative methods.

The methodology proposed in this report, will be able to determine each steps needed to design and implement a simulator based training program according to the aim of the OPTIMUS Project

In the training evaluation section, the most important section of the OPTIMUS Report, our experimental methodology should be able to identify also different level of evaluation tools: from simple to complex training evaluation models, defining specific objectives and specific operative tools.

## SECTION 1 - Introduction

## **1.1 COMPETITION AND TRAINING IN PORT SECTOR**

In according to Melitiou (2006) for the last few decades, the focus of the port sector has been mainly on technological advances that make productivity less dependent on human effort, knowledge and skills. But recent years have witnessed a growing acknowledgement by the port industry that appropriate attention must also turn to performance improvement through people.

Ports should be seen as “socio-technical” systems because, in practice, operations in port terminals are carried out by a partnership between human beings and technology.

The task of finding port personnel who either possess or have the potential to develop the knowledge, skills and attitudes that will enable a port business to carry out the tasks necessary for the achievement of its aims and objectives is obviously of fundamental importance.

Although the selection of port personnel is usually designed to recruit the most competent individuals, they are unlikely to remain competent for the whole of their career.

As changes take place in technology, infrastructure, procedures, competition, interfaces with other modes of transport, knowledge and innovations, so too will the demands placed upon specific jobs in the port industry.

Such changes may also lead to the creation of jobs and disciplines, which are new to the traditional port industry.

This is where training, and simulation based training is represent the most advanced training tool used in port sector, comes in and it is linked to the improvement of port performance.

At organizational level **Port Performance** comprises the following three basic outputs: Effectiveness + Efficiency + Port personnel satisfaction

Port Performance is measured in terms of:

- **Effectiveness (accomplishment of explicit or implicit tasks)**
- **Efficiency (Best possible utilization of resources)**
- **Port personnel (Knowledge and skills)**

Obtaining, employing and retaining suitable port personnel that would contribute to the effectiveness. the efficiency of the port is costly and requires considerable effort. Therefore ports have a very strong vested interested in ensuring that these human resources are utilized as effectively as possible.

There is convincing evidence that many ports are falling far short in making effective use of all the people they employ.

To do this a port organization has to recognize that people are its most valuable asset, that they are not simply another factor of production for the achievement of short-term objectives.

It should also be recognised that port personnel can become a reservoir of knowledge and skills, which must be nurtured and developed for the survival and future growth of the port business in the constantly changing and increasingly complex port industry environment.

Experience from some port organizations (a good example is that of PSA – Port of Singapore Authority) suggests that investments in people have resulted in substantial gains towards the achievement of the port’s strategic objectives.

There is no need to overemphasize the importance of “Getting the right people and getting the people right” but defining these twin concepts is a step further towards achieving increased port performance through people.

**“Getting the right people”** means planned recruitment processes, which provide the port business with the best available talent, consistent with the needs of the port business and its capacity to make full use of those recruited.

### **Getting the right people**

**Planned recruitment processes,  
Best available talent  
Optimization of roles and employment  
Matching with needs  
Planning of business  
Capacity to make full use of recruited.**

**“Getting the people right”** implies consistent policies and practices in training, retraining, educating and developing port staff and involving them as “partners” in the port business rather than as functionaries whose roles are restricted to obeying instructions.

### **Getting the people right**

- **Policies and practices in training,**
- **Retraining and educating**

- **Development of port staff**
- **Participation to port business**

It is obvious that “Getting the people right” implies two categories of human resource policies and practices. The first category is related to learning processes and the second to port personnel motivation.

However, it is important to point out that the provision of opportunities for appropriate training, education and development is one of the proven strategies for port workforce motivation.

## **1.3 TRAINING, TRAINING METHODOLOGY AND SIMULATION BASED TRAINING**

### **1.3.1 The training process**

Training is necessary to achieve improvements in work performance, particularly when ports invest in new equipment, introduce new work procedures or redesign the workplace.

Training takes place at a specific time and place, is usually vocationally relevant and limited to specific aims and objectives.

Since training is essentially a learning process, all those involved in port training need to have an understanding of learning and what needs to be taken into consideration in the design and provision of training in the port sector.

“Learning” is a permanent change in behaviour that comes about as a result of a planned learning experience. (In simple terms training could be defined as the design and implementation of effective learning experiences).

In the context of training it is useful to consider learning and behaviour change in three types of behaviour, **cognitive (knowledge), psycho motor (skills) and affective (attitudes)** needed for effective performance.

These are outlined here below:

*cognitive (knowledge)*

*psychomotor (skills)*

*affective (attitudes)*

How people learn has been the subject of continuing discussion for many decades. Various theories have been fashionable but in our practical experience acquired, it is possible to distil some basic, simple, general truths about learning, which are usually referred to as the “principles of adult learning”. These are outlined here below:

**Learning depends on motivation.**

Trainee must see a beneficial outcome for themselves. They must see how training could help them to perform their work efficiently. They must see a personal need for this to happen and to accept the methods chosen to achieve the training objectives. Port training management as well as trainers are responsible for creating an environment and conditions conducive to this motivation.

**Learning depends on feedback.**

Feedback is important to the learning progress. People need to have feedback on their learning achievements. The trainee needs to be reminded of how he is progressing and where his strengths and weaknesses lie. If the learner is doing well then positive feedback will reinforce the process. If the learner is performing poorly then instant feedback is needed to correct and eradicate poor performance.

**Learning experience must be meaningful.**

The learner will succeed if the learning experience is perceived to be meaningful and relevant. Training courses need to satisfied this criterion by being specifically relevant to the day-to-day needs of trainees.

**Goals must be set.**

Active participation in relation to specific learning goals creates a situation, which is highly stimulating to most learners. Human beings are naturally competitive and will strive to attain targets that are established for them. The use of clearly stated aims and objectives for trainees will help in this respect.

**Learning depends on the capacity to learn.**

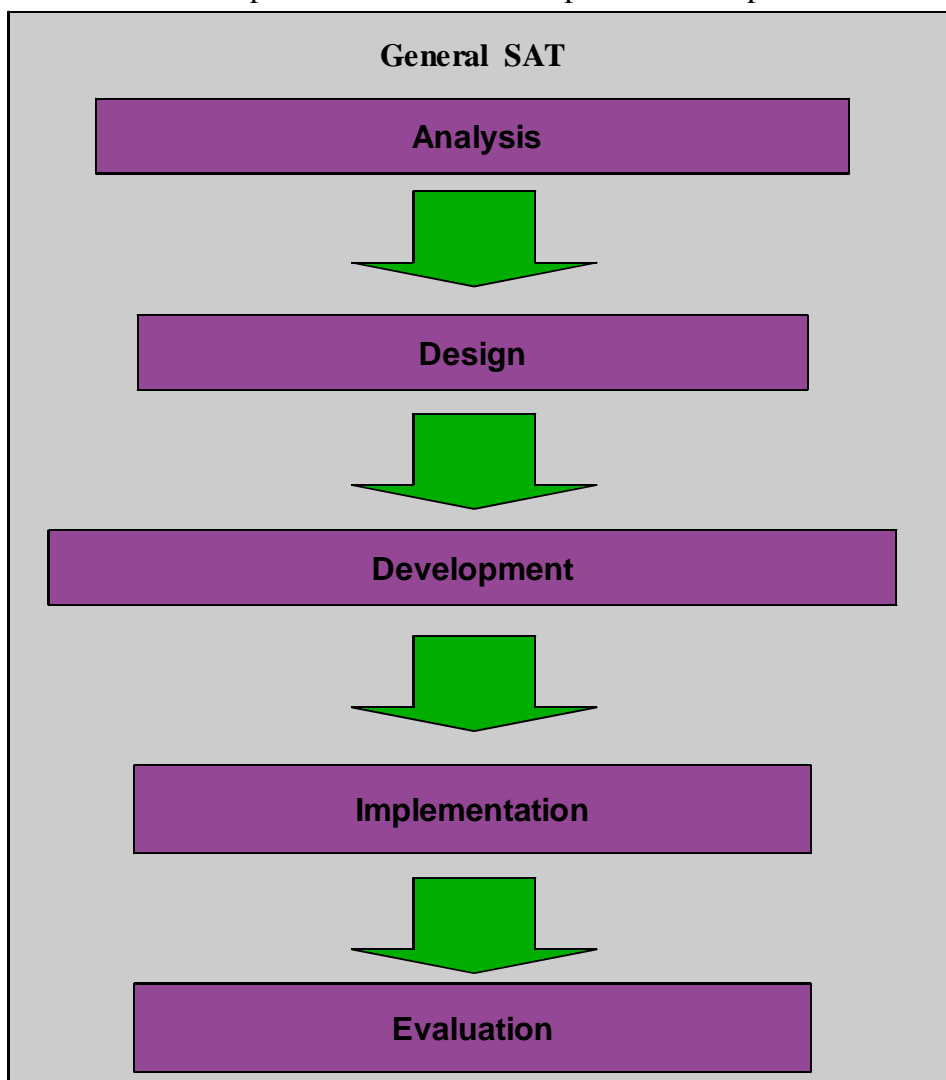
A few adults who are performing adequately in their jobs are incapable for further learning, especially if that learning is itself work-related.



### 1.3.2 SAT Methodology

The training methodology that we choose for OPTIMUS Project is an adaptation of SAT, Systematic Approach to Training, to simulation based training. SAT was used during World War 11 by the U.S. Military to train soldiers in aircraft recognition.

At general level the SAT model may be pictorially represented as a linear model, but decisions made in one phase affect actions and plans in other phases.



### **Analysis**

Analysis provides a method of responding to changes in human resource requirements, solving job performance problems, and learning from “*real world*” experience. In the analysis phase, detailed practical studies are performed to determine what areas require instruction, learner characteristics, cost-effectiveness of a selected delivery system (e.g. simulation based training SBT, and the scope, time line, and budget of a training project/program.

### **Design**

Design uses the performance information collected earlier to help the training project/program take shape. The information gathered specifies the knowledge, skills, and aptitudes that training will develop. Learning objectives are developed for groups of related knowledge and skills, and are produced to ensure that learning objectives are achieved and competencies are reliably evaluated.

### **Development**

Development organizes the instructional materials needed for learners to achieve the learning objectives. Instructor and learner activities are defined and these activities describe how the instructor and learners will perform during training to achieve the learning objectives.

### **Implementation**

Implementation is the process of putting the training project/program into operation. This finalized training is ready to be delivered to the target audience. Training is delivered as planned and learner and instructor performance is evaluated.

### **Evaluation**

Evaluation phase ensures training’s continuing ability to produce qualified workers. . Evaluation is the dynamic process of assessing performance, identifying concerns, and initiating corrective actions.

The main advantages that can be achieved by SAT training development methodology are:

**SAT permits effective management control.**

Because measurable objectives are established and performance is evaluated and documented regularly, those responsible for training can measure and correct performance.

**SAT is fully accountable.**

It includes training in skills and knowledge required for performing the job properly, as determined through a systematic analysis.

**SAT provides for continual feedback.**

Training effectiveness is monitored systematically, and the results are used to improve training program design and implementation.

**SAT is cost effective.**

Properly implemented, only elements for proper job performance are included in the training program. Resources can be allocated properly and justified.

### 1.3.3 Advantages of Simulation based training

**Simulation** enables creation of dynamic, real life situations in a controlled classroom environment where people can:

**Practice new techniques and skills;**

**Obtain insight from instructors**

**Transfer theory to real-world situations in a risk-free operating environment;**

**Deal with multiple problems concurrently rather than sequentially;**

**Learn to prioritize multiple tasks under similar high stress, changing conditions to those in actual port operations**

The use of simulators for training is based on the concept of skill and training transfer is, the ability to adapt skills learned in one context to performance or task execution in another. The "fact" of transfer constitutes the basic justification for all formal training programs: it is assumed that skills and knowledge learned in a classroom can be applied effectively to relevant situations outside the classroom.

To ensure that all training goals are met, it may be appropriate to supplement the learning with apprenticeships or a similar formal mechanism to reinforce the learning process.

Traditional classroom teaching has been an effective method for teaching theory.

With the addition of simulation to the course curriculum, the instructor can fill the gap between theory and application

The use of simulators is becoming a good method of training in the international port and marine industry. Yet even as more simulators are being used, their use has not dovetailed smoothly into comprehensive training programs.

**The fundamental aim of OPTIMUS Project is to develop a experimental methodology of training design and evaluation in Port sector focalized on use of simulation training devices.**

Many simulator-based training courses were developed *ad hoc*, often designed to individual requirements of a port and maritime company or training establishment.

Simulators can also be used effectively to bring a new dynamic into the classroom by combining books and lectures with real-time simulator-based instruction to teach real operating skills.

Although simulation can be a high or relatively low-cost option for training, use of simulation must be based on its suitability to training objectives.

Simulator-based training permits hands-on training to be conducted in a realistic environment without interfering with the real cargo handling operations and exposing it to risk. Training can continue independent of adverse weather conditions, vessel operating schedules, and other training conditions.

Simulators allow students to repeat a risky operation several times if needed. Unlike training on operational equipment, where an instructor must be prepared to intervene at all times, risky manoeuvres can be safely practised on a simulator.

In on-the-job port sector training, concerns for safety of the crane cause an instructor to intervene earlier than is desirable for efficient progress of learning. During real operations, it may be necessary to interrupt training to avoid a real life accident.

In simulator-based training, the instructor can allow students to make mistakes, to see the consequences, and possibly to practice recovery procedures.

Using simulation, the instructor can terminate a training scenario as soon as its point has been made or repeat it until the lesson has been well learned.

In contrast, opportunities for repetition are very limited during actual cargo handling operations; for instance the opportunity to repeat an exercise in on-the-job training may not occur for weeks or months.

The main advantages of simulator based training are outlined below

### **Recording and Playback.**

One of the most important feature of simulator-based training is the ability to record and play back the just-completed scenario for review, evaluation, and debriefing purposes. As a teaching tool, recording and playback empower the instructor to let mistakes and accidents happen for instructional emphasis and allow trainees to review their actions and experience the results of their performance.

### **Flexibility.**

Simulator-based training permits systematic scheduling of instructional conditions as desired by the instructional staff or as directed in the training syllabus. Simulation permits the use of innovative instructional strategies that may speed learning, enhance retention, or build resistance to the normally disruptive effects of stress.

### **Multiple Tasks and Prioritization.**

Use of simulation in training programs makes it possible to transfer classroom skills and to practice and prioritize multiple tasks simultaneously. Simulation training enhances development of skills and provides the opportunity to exercise judgement in prioritizing tasks.

### **Training on New Technologies.**

By employing features such as the ability to repeat training exercises and to record and play back performance, simulators can provide a safe environment for training port workers in the use of new equipment. For some new equipment it is possible to place desktop simulators on board to provide an opportunity for independent training.

### **Cost Effectiveness**

Although the most obvious goal of using simulation is **improving performance**, cost effectiveness is also important. Simulators in many sectors cost less to build and operate than the operational equipment being simulated.

### **1.3.4 Simulation based training in port sector: Dock Gantry Crane Operator**

BCMEA - British Columbia Maritime Employers Association of Canada - uses an interactive simulator for the delivery of training programs to port operators.

The simulation devices that are used in BCMEA experience are able to simulate operating scenarios for different types of equipment.

- Pedestal Cranes
- Ship Gantry
- Dock Gantry
- Rubber Tire Gantry

The association of Employers expect training programs to train and deliver a complete operator and BCMEA have a whole control of the bench mark for port crane operator, for instance this organization underlined that the bench mark of experienced port gantry crane operators average 25 moves per hour.

Within BCMEA experience we should summarize and analyze the different training programs for gantry crane operator with traditional on the job training methodology and with the use of simulation training devices.

The main results are summarized below

#### **1.3.4.1 Traditional training process**

The training process delivered for a dock gantry operator without the use of simulation devices need a duration of 30 days to achieve the benchmark of 25 moves per hour.

DockGantryOperatorTraining= 30 days on the job training.

- 1st day on the job, trainees average 15 moves per hour.
- They require an average of 30 days to reach 25 moves per hour.

#### **1.3.4.2 Simulation based training process**

With the use of simulation devices for gantry crane the training process of Dock Gantry Operator is limited to 15 days.

The whole training program is composed in 5 days on the simulator and 10 days on the job training and the main advantages of the use of simulation devices are underlined below.

- Trainees develop essential skills on the simulator prior to working in production.
- 1st day on the job, trainees average 23 moves per hour.
- They require an average of 10 days on the job to reach the benchmark of 25 moves per hour.
- Length of program is reduced to from 30 to 15 days.

### **1.3.4.3 The most important findings of BCMEA Experience**

The main Factors that impact the scheduling and effectiveness of traditional training include

- Access to equipment
- Duration of the training program
- Training in production
- Lack of opportunity for specialized manoeuvres
- Cost

Advantages of simulation based training include

- On-the-job training time significantly reduced minimizing impact on productivity
- Reach production targets more quickly
- Practice difficult manoeuvres with no risk to cargo or equipment
- Wide variety of operating conditions and safe, controlled environment
- Realistic scenarios help to develop specific skills
- Progressively more complex scenarios as skills improve
- Output a greater number of qualified operators in a smaller amount of time

### **1.3.4.4 Training programme outline**

#### **Goal**

Trainees will be able to discharge and load container vessels, following safety measures, precautions, operating principles and rules that ensure the safe and efficient use of the dock gantry crane.

#### **Program Description**

This training program covers the basics of dock gantry operation through classroom instruction and hands-on training.

Trainees develop knowledge of general and site-specific safety policies and procedures in addition to knowledge of cell vessel numbering, hand signals and operating procedures.

Through demonstration and practice on simulators and in the work environment, trainees develop skills in performing pre-operation checks, parking, stopping & shutting down the dock gantry, loading and unloading bombcarts, using spreaders and attachments to handle containers on-deck and under-deck, and controlling swing & trim.

Trainees are expected to pass a written examination and to demonstrate an established level of performance for each operating procedure.

**Pre-requisites**

Topside or Rubber Tyre Gantry rated.

**Pre-qualifying**

Signed the appropriate ILWU job posting sheet for the current year, within the prescribed deadlines, and validated with the BCMEA scheduler eligibility to receive training.

**Educational**

N/A

**Experiential**

N/A

**Medical**

Pass an eye and hearing examination conducted by a doctor of the trainee's choosing.

Candidate must possess adequate colour perception, hearing and visual acuity.

**Working Conditions**

- Elevated heights
- Continuous working for 4-hour periods

**Delivery Methods**

Classroom, simulation and on-the-job training

**Training Materials**

Dock Gantry Crane Operator's Training Program Manual

Dock Gantry Crane Operator's Quick Reference Guide

**Duration**

Up to 20 days, depending on training location

# 1 SECTION 2 – Guidelines

## 2.1 SIMULATION BASED TRAINING GUIDELINES AND METHODOLOGIES

The SAT adopted within the OPTIMUS project is a methodology that comprises a step wise procedure for the specification of training program requirements.

This methodology is specifically focused on the specification of training program for simulators and is more restricted in scope than other SAT methodologies.

An effective training program addresses the student's training needs with respect to knowledge, skills, and abilities. SAT approach is very useful methodology to develop effective training program and this process is central to the overall focus of this report.

**SAT Methodology** is suitable to traditional training design and **to Simulation Based Training too.**

The focus of this report is that the use of simulation devices for training is very useful to optimize time, resources and effectiveness of the learning process and the overall training program.

As remembered, SAT is an iterative process whereby training managers or port authority continually test results of training programs and improve training analysis and design. It is an incremental approach that involves inserting new pieces developed by the SAT Process into existing training programs, assessing results, and then revising the program as necessary.

This systematic application yields simulator-based training programs with clearly defined objectives, carefully designed training and evaluation scenarios, and qualified standards of instruction and instructors.

In our opinion we have the same steps to design an effective training program but the simulation will play a fundamental role and will be very useful to accelerate learning dynamics in the trainee population.

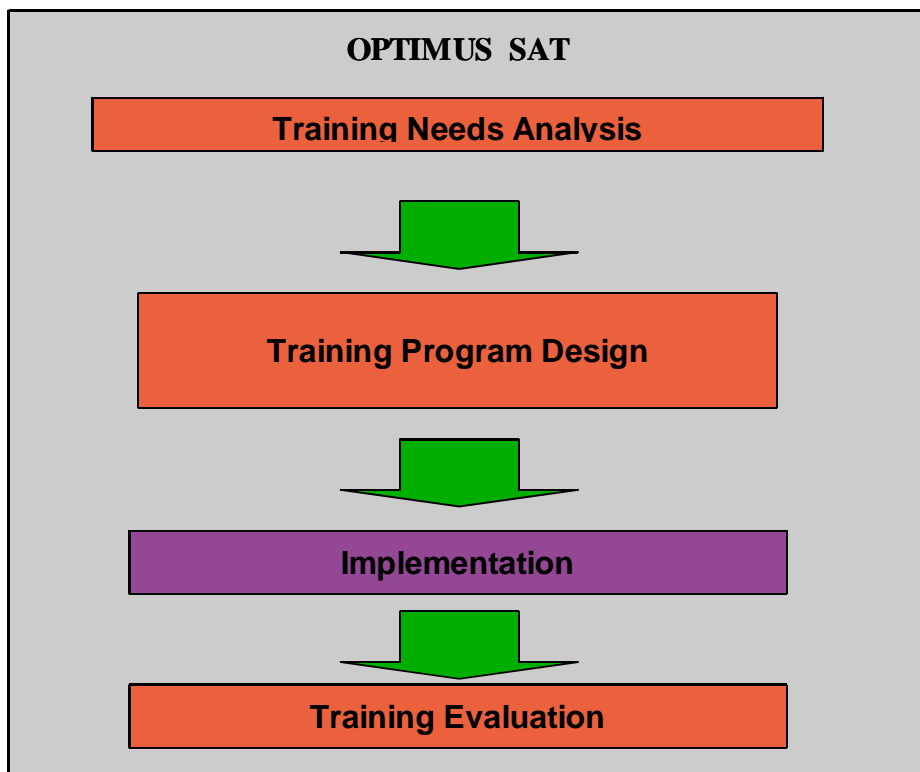
For these reasons we developed an adaptation of traditional SAT process to port sector and to simulation based training and we focused the attention on the most important steps of the designing process.

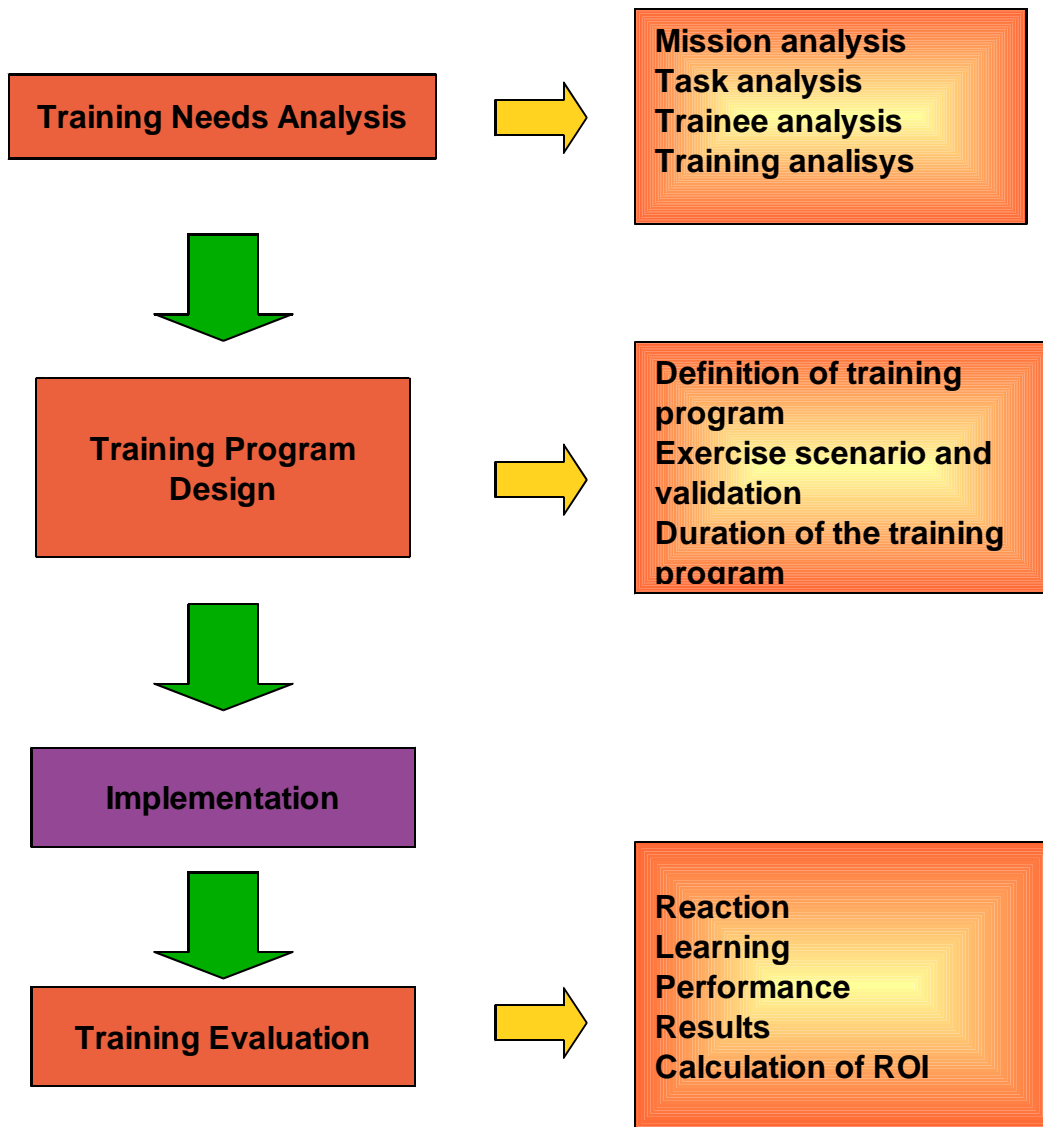
In these steps we underlined the use and the advantages of simulation devices.

There are several stages to implementing the SAT process for Simulation Based Training in port sector: this report does a synthesis of a general SAT schema to fit to main purposes of port sector.

The most strategic and important phases that are identified for OPTIMUS Project and these guidelines and methodologies on simulator based training are:

- 1. TNA training needs analysis**
- 2. TPD training programme design**
- 3. TE training evaluation**





## **2.2 SIMULATION PLATFORMS SPECIFICATIONS**

In the OPTIMUS project the existing simulation platform – in Valencia, Livorno and Marseille - are technological constraints.

The proposed methodology is suitable to analyse training needs and design training of a simulation based training programme even if we have technological constraints due to existing simulation platforms.

The first two steps of the OPTIMUS Methodology are Training Needs Analysis (TNA) and Training Program Design.

During TNA the training need is described and determinate in form of a set of related training objectives and during TPD training objectives are translated into training programme activities and programme requirements.

During Simulation Platforms Specification (SPS) training program requirements are translated into simulator requirements. In practice the output of TPD constitutes the input of SPS, a prospective training program that is to be at least partly delivered by means of training simulator.

The output of SPS consists of a set of functional simulator requirements linking training program requirements to simulator requirement.

In the OPTIMUS project we consider Simulation Platforms Specification as a constraint and we link training programme specification to the simulation platform constraints by trying to elaborate new evaluation methodologies directly connected to the needs of Port Authorities involved in the project.

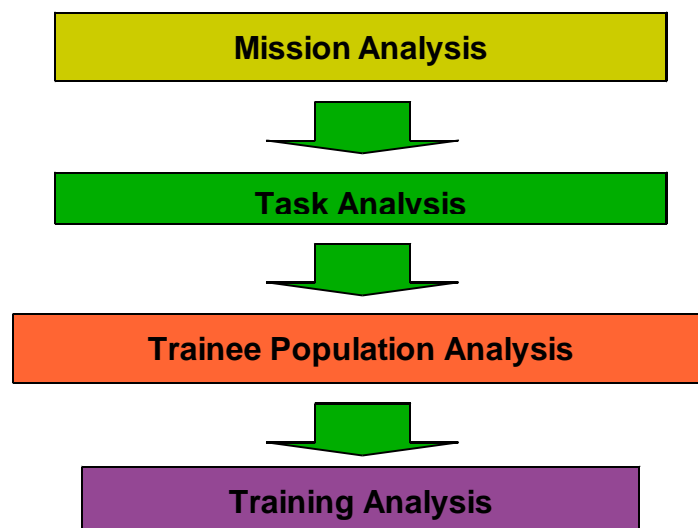
## 2.3 TRAINING NEEDS ANALYSIS

The most important and starting point of any training program that may stand any chance for being successful is **the structured identification of training needs**.

It is a primary requirement to design and implement an effective training program that it must meet the actual, rather than imagined needs: below we could underline the most important substeps of this activity.

The purpose of the Training Needs Analysis is to define training need in terms of set of related training objectives, this is accomplished in a number of consecutive iterative substeps:

1. **mission/aim analysis**
2. **task analysis**
3. **trainee analysis**
4. **training analysis**



The first two steps, mission/aim and task analysis, are required **to describe the operational behaviour of the operator and the system** and behaviour is considered to be a result of the goal oriented deployment of operator functions.

The identification of these aspects are fundamental to set simulation devices and scenarios.

This approach implies that any description of behaviour should comprise a description of the goal, and description of functionalities and strategy to achieve the goal: this is not only a hierarchical decomposition of the systems and associates goals but the assumption is that behaviour is organised in terms of goals and their inter relations.

In the context of the Training Needs Analysis TNA the purpose of mission/aim and task analysis is to provide a sufficient **comprehensive and accurate description of operational behaviour**: description can be used as a basis for identifying and defining training objectives

In particular the process of aim and task analysis should result essentially in the specification of the required functionality of the operator but before the results of TNA can be defined in a set of related training objectives two further steps have to be taken: trainee and training analysis.

One of the main purposes of trainee analysis is to assess the extent to which the required skills are available in the candidate group: this information is necessary to determine if supposed training needs exist and to tuning training facilities and simulation devices.

The purpose of training analysis, final step in TNA methodology is the identification and definition of training needs in terms of set of related training objectives: training objectives are defined in terms of performance objectives, conditions and norms and they represent the final results of TNA activities.

## 2.3.1 Mission or Aim analysis

A valid, complete and real representation of the mission/aim is a necessary basis for task analysis and training analysis, the specifications of training scenarios, and ultimately the specification of functionalities of a specific simulator to be used.

What are the risks of not performing mission analysis prior then task analysis?

The main risks are outlined below

1. Inadequate specification of performance and process measures
2. An excessively focus on individual task and disregard of team task. This issue in a complex work environment like a port system will be very dangerous for the whole training program.
3. Not identified all personnel involved in system changes
4. Inadequate specifications of all training conditions and inadequate training for such conditions
5. Over emphasis on training partial task

### 2.3.1.1 Definition of mission/Aim

A *aim* is a general statement of intent that describes the general nature of the topic to be taught but does not define the trainee skills.

An example of a set of training aims, which is drawn from the ILO PDP (Unit C.2.3: Container Securing Systems), is the following:

## UNIT C.2.3: Container Securing Systems

### Unit Aims

This Unit is designed:

- To explain why containers need to be secured during the sea

**voyage.**

- **To describe the main types of securing devices used on container vessels.**
- **To explain how container securing devices are used.**

### **2.3.1.2 Requirements for Mission/Aim Analysis**

Several data sources can be tapped for the purpose of mission/aim analysis, therefore a combination of methods is typically used.

Existing descriptions of operational situations then differ in level of abstraction and are rarely used for the analysis of training goals.

**Several sources are useful: documents, subject matter experts and direct observation.**

Example of documents are manuals and research reports: such documents are not usually produced with objectives of mission and task analysis for training programme design. This normally necessitates a process of translating and filtering relevant information which can be very difficult and does not guarantee completeness.

Information gathered from SME is usually more up to date and more focused but it is possible that it is from a limited or partial operative experience.

Direct observation is more expensive and time consuming and in some cases impossible: it is very useful to provide initial orientation.

## Mission/aim analysis

**A *aim* is a general statement of intent that describes the general nature of the topic to be taught but does not define**

**The results are used for:**

- task analysis and training analysis,**
- the specifications of training scenarios,**
- the specification of functionalities of a specific simulator to be**

## 2.3.2 Task Analysis

### 2.3.2.1 Definition

Task analysis leads to description of the operational behaviour of operators within the context of a aim or mission. The term task is used in literature in different meanings and different dimensions of tasks are studied.

- task is a system function that as been allocated to a human operator
- task analysis is a systematic description of a task performed by an operator and showing the sequential and simultaneous cognitive and motor activities.

In this report task is seen as an assignment to be completed.

Task analysis is useful for training system development because its results are used in formulating training objectives by:

- **identification of final behaviour**
- **description important conditions under which behaviour will be expected**
- **specification of criteria of acceptable performance**

In task analysis information collected is used to decide

- How to train
- What to train
- How much to spend on training

In the context of training on simulators the purpose of task analysis is more specifically given to identifies the information needed to support the operator task practice in the simulator and also defines training functions to be supported in the simulator.

## Task Analysis

**The results are used for:**

- 1) identification of final behaviour**
- 2) description important conditions under which behaviour will be expected**
- 3) specification of criteria for acceptable performance**

**In task analysis information collected is used to decide:**

- 1) How to train**
- 2) What to train**
- 3) How much to spend on training**

### **2.3.2.2 Task Analysis Sources**

The sources of informations can be identified: documents, subject matter experts and direct observation

Traditionally, professional development in port sector has relied pre-dominantly on "modelling the expert" for complex cognitive tasks—the person undergoing training watches and imitates the performance of senior professionals.

This modelling is generally accomplished through on-the-job observation and hands-on experience. There are two obvious difficulties in using direct modelling for complex cognitive tasks:

- performance of the tasks is not only opaque to observers, but may also be implicit for the experts: they may not be able to describe their own thought processes or the rationale for them, even though they can perform the tasks.
- in order to properly coach a novice, an expert may have to formulate an accurate mental model of the novice's understanding of the task (sometimes called the student model).

The SAT process offers an alternative to on-the-job or "modelling-the-expert" training methods.

Without a more fully developed basis for quantifying actual training needs, the use of simulators in professional development of port workers will continue to be based on perceived needs and professional estimates.

In our opinion, to optimize use of simulation devices, we need a deep and structured task analysis on the basis of adaptation of SAT process.

To apply SAT instructional design, it is necessary to have detailed, relevant task and subtask analyses.

The task analyses needed to define training needs in SAT instructional design should be detailed and include descriptions of steps required to complete identified subtasks.

### ***2.3.2.3 Approach to task analysis***

In practical approach to task analysis there are four important steps:

#### **Operator and relevant task identification**

This is seemingly a simple step but is possible in practice identify cases in which it has been omitted.

## Identification of task goal and decomposition of task

Task goals are identified in the context of actions. From the mission/ aim analysis a list of task with functions serves as primary input for a further decomposition.

## Task specification and description

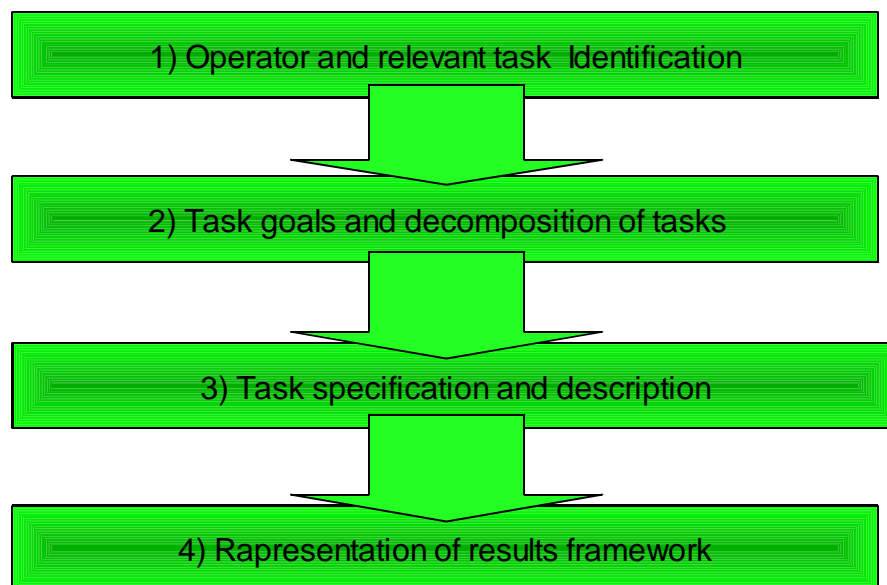
Task analysis is supported by specific techniques to organize information about human involvement in a system, creating a detailed picture from a human prospective.

Techniques of task description are

- time-line analysis – *focus on sequence* –
- flow process charts or operational sequence – *focus on vertical dimension* –
- critical task analysis – *focus on operator task that impose high workload*

## Representation of the results in a frame work

This section is involved in framework representation of task analysis results



#### **2.3.2.4 Differences between Task and Skill**

As we remembered before, **Task** can be viewed from different perspectives: for instance, the responsibility assigned to a person, or referred to operational goal that to be accomplished as part of particular responsibility. It may be used to denote the procedure that is to be executed to achieve an operational goal.

**Skill** is a learned capability of a person to perform particular acts: to be skilled means to have capability to reach specific level of proficiency. Skill proficiency can be assessed by a test which can be viewed like a standardised task designed to measure a particular skill.

A skill is a characteristic of a individual person that enables the person to perform particular task, this is latent and becomes manifest only in the performance of a task or in testing activity

It is also called **competency**

#### **2.3.2.5 Definition of training objective**

A **training objective** is a statement of the skills, which a trainee will have after completing a training programme.

These new skills imply a behaviour change in one or more of the three types of behaviour, which is associated with the learning process [cognitive (knowledge), psycho motor (skills) and affective (attitudes)].

For this reason it is useful to classify training objectives in a similar manner as follows:

##### **Cognitive training objectives**

Associated with learning facts, principles, procedures analysing data, evaluating problems, undertaking calculations, etc.

An example of a cognitive training objective.

## **ILO Portworker Development Program**

### **Unit C.6.2 Measuring Container Terminal Performance**

**After completing this Unit, the learner will be able to:**

**“Given data relating to the utilization of various terminal facilities and resources, calculate correctly the relevant utilization measures”**

#### **Psycho motor training objectives**

Associated with practical processes involving hand / brain coordination, e.g. Driving a forklift truck.

One example of a psycho motor training objective

## **ILO Portworker Development Programme**

**After completing this training, the trainee will be able to:**

**“Operate a container crane safely and efficiently”.**

#### **Affective training objectives**

Associated with the correct attitude of workers and managers to the job, the company, their colleagues, customers, etc. Affective training objectives

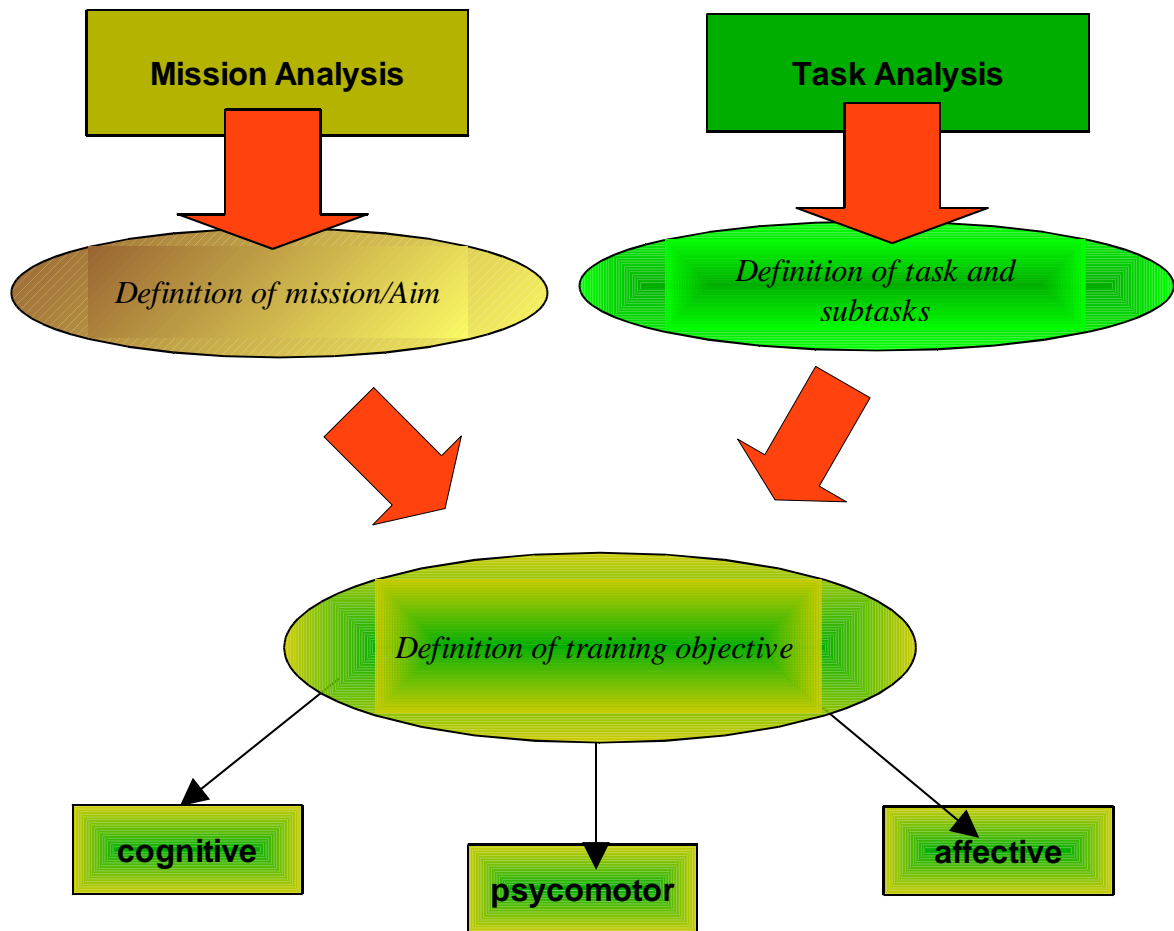
Associated with the correct attitude of workers and managers to the job, the company, their colleagues, customers, etc.

One example of an affective training objective.

## **ILO Portworker Development Program**

### **Unit P.3.1 Handling Dangerous Cargoes in Ports**

**State why port workers must know how to recognize dangerous cargoes encountered in ports and the risks associated with them and handle them safely.**



### **2.3.2.6 An Example of whole Unit from portworker development programme**

Container ship loading and discharging operations

#### **Unit Aims, Objectives and Prerequisites**

##### **Unit Aims**

This Unit is designed:

1. To outline the four components of the ship operation , for loading and discharging.
2. To describe the principles followed when planning stowage on container ships and to explain how stowage affects the sequence of loading and discharge of containers.
3. To describe the lifting equipment used in container loading and discharging.
4. To describe the sequence of activities that make up the ship operation, for both lift-on-lift-off and roll-on-roll-off vessels.
5. To describe the work of the personnel involved in the ship operation.
6. To outline the safety procedures that must be followed in the ship operation.

##### **Unit Objectives**

After completing this Unit, the learner will be able to:

1. List and describe the component activities of the ship operation, for lift-on-lift-off (LoLo) and roll-on-roll-off (RoRo and StoRo) operations.
2. State and explain the major safety principles followed when planning the stowage of containers aboard ship.

3. State and explain the major operational needs taken into consideration when planning container stowage.
4. Describe in general terms the form and use of the ship operation work schedule documents, and outline the principles followed by planners when preparing them.
5. Name and distinguish between the four main types of quayside crane used for handling containers, and their ship-mounted equivalents, and describe their operation in general terms.
6. Distinguish between the five main types of spreader beam used for handling containers and describe their operation in general terms.
7. Describe the sequence of activities performed in a typical LoLo ship operation and the record-keeping requirements associated with activities.
8. Describe the sequence of activities performed in a RoRo ship operation.
9. Describe the work activities of the personnel involved in the ship operation, both aboard ship and on the quayside.
10. List and explain the safe practices and good 'housekeeping' rules to be followed in the ship operation.
11. Define, recognize the best definition of, or distinguish between true and false statements concerning, the technical terms used in the Unit, as listed in sections 3 and 4 below.

### **Unit Prerequisites**

It is assumed that trainees will, before starting this Unit, have completed successfully the following Units or will have demonstrated (for example by successfully completing the Tests for those Units) their understanding of the topics covered by them:

- Container terminal operations (C.1.1)
- Container construction (C.3.1)
- Container numbering and marking (C.3.2)
- Container ship construction (C.2.1)
- Container ship stowage plans (C.2.2)
- Container securing systems (C.2.3)

### 2.3.3 Trainee Population Analysis

The task and skills identified during task analysis are required to perform the tasks adequately.

There is great diversity in the professional backgrounds and maturity of trainees. Group members may range from entry-level to mates and this diversity can affect the development of effective training program because of the possible range of training needs – entry - level training; refresher training; and familiarization training on specific equipments.

Training programme and time is dependent on:

- number of trainees
- learning difficulty of the skills to be acquired
- variability of the initial level of skills
- variability of learning potential

Usually the trainees with the lowest initial learning potential determine entry training level, total training time and simulation based training time.

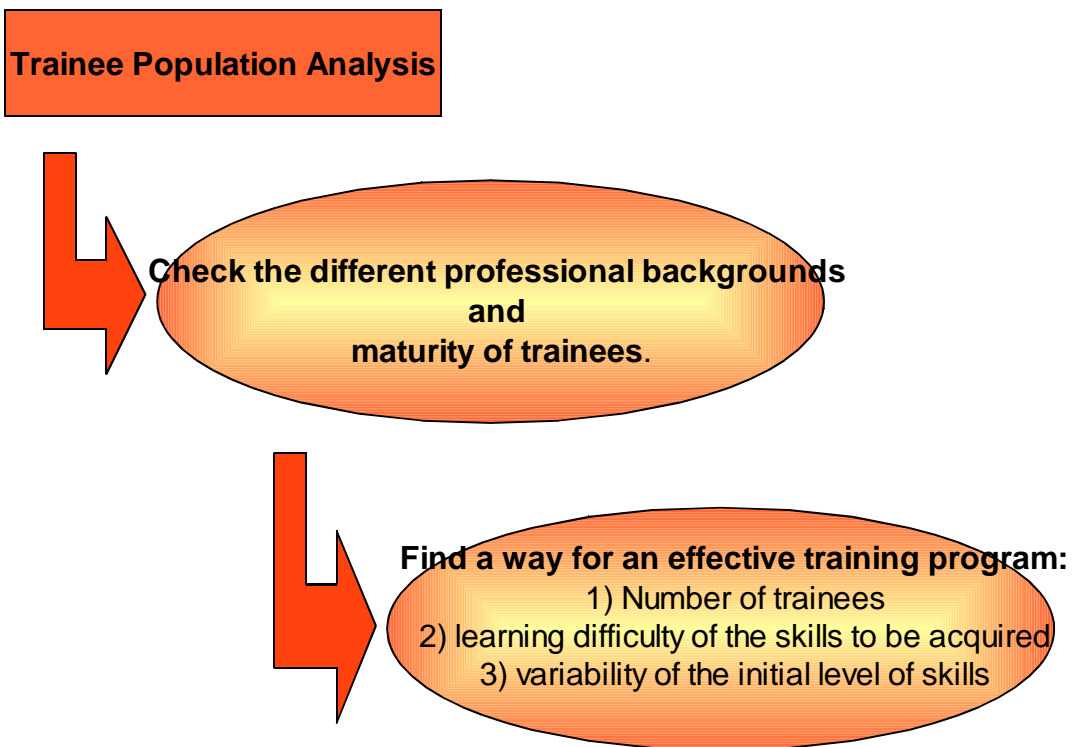
#### **2.3.3.1 Procedure of Trainee analysis**

The first step during the trainee analysis is to identify potential group of trainees. This can be done on the basis of analysis of people holding similar jobs or having relevant educational background. The purpose of selection is to select from the people who apply for training, those who possess specific critical skills identified as predictors of training success. Various selection procedures can be adopted, and the cost of these procedures is also an important consideration. For the purpose of

selection a broad distinction can be made between general standardised tests and work sample tests. In particular work sample test assess job specific skills by letting subjects perform characteristics job tasks. Work sample test have a high degree of face validity for subjects and tester and may become more objective if work sample test are conducted on simulator.

**In this case the systematic use of simulation devices play an important role in trainee analysis.**

A frequently used option is to use standard psychometric test for initial phases of selection and to use more expensive and resource intensive selection during subsequent phases with a fewer remaining applicants. The aforementioned type of tests all yield an estimate of skill level but do not provide information about the learning potential of the trainees and may be an important determinant of training time and training costs. As underlined in assessment of candidates section, selection procedures can be evaluated in terms of their predictive validity and the intended outcome of the selection procedure is a group of trainees whose skills are within range that is assumed at the beginning of the training. Selection and training serve the same goal: improving the fit of individuals to task requirements at the lowest possible costs and simulation play an very important role. Ultimately the training need is determined by the discrepancies between the required skills and the skills already available within the pool of selected applicants.



### 2.3.4 Training Analysis

Training analysis constitutes the final step of TNA.

Its general purpose is the definition of training needs in terms of set of related training objectives used as ultimate criteria for training success.

- The starting point for a definition of a training need is the discrepancies between required and available skills.
- The required skills will be identified in task analysis.
- The available skills will be identified during trainee analysis.

Training analysis is concerned with specification of the training need in terms of set of related training objectives. Essentially, this specification consists in a translation of the discrepancies between required and available skills into a set of objective skills test that, when successfully passed, provide guarantees that trainees will be able to meet operational performance requirements. The use of simulation devices make this dynamics more easy and minus time consuming.

#### **2.3.4.1 Importance of training analysis**

An accurate description of training objectives is very important because it specifies the final criterion of training and because is the starting point of training program development. Training objectives specify the standard of performance to be achieved by training: too often training objectives are formulated too vaguely and the risk is that they may be interpreted in different ways by the staff, instructors or trainees.

In addition, they provide insufficient guidance and constraints in focusing training programme development. The consequence maybe a more time-consuming development process due to the extra iterations required to resolve ambiguities.

#### **2.3.4.2 Requirements for training analysis**

The starting point for the specification of training objectives is the output of task analysis and trainee analysis the out put of task analysis is an ordered sets of aim or mission related task descriptions. These task descriptions include a specification of operator functions and skills required to perform the tasks. The output of trainee analysis consists of skills profiles of the potential groups of applicants who may apply for training.

### **2.3.4.3 Procedures for training analysis**

The first step is to delete from the skill profiles obtained from task analysis the skills that are already sufficient mastered by the trainee. The result is a specification of training needs in terms of reduced set of task specific skill profiles.

The second step is to select a minimal set of task to training objectives: tasks that require the same types of skill can be clustered and for each skill relevant task. A training objective is the operationalisation of a test item.

The specification of training objectives can be viewed as the design of domain specific test battery.

**Training Analysis**

**Check the discrepancies between Required and available competencies**

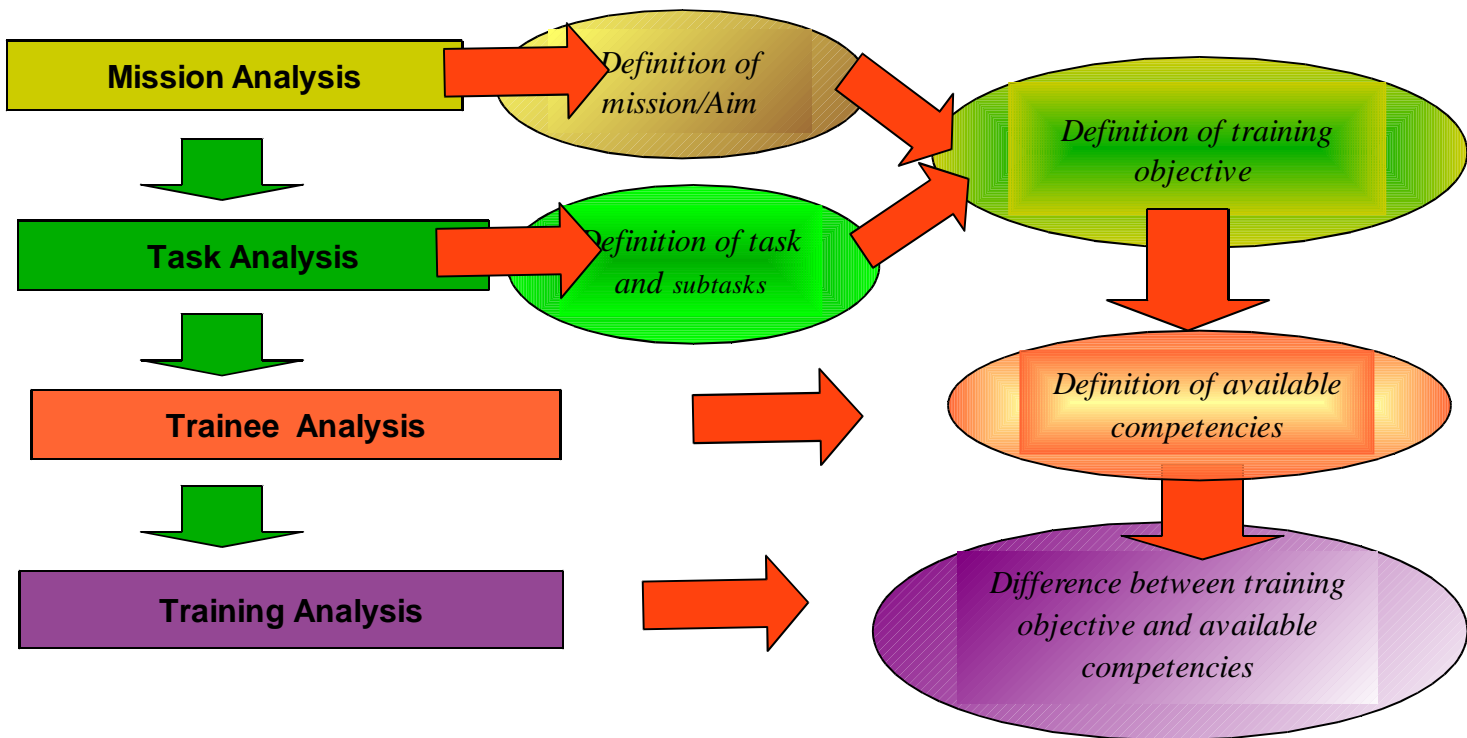
**It is concerned with definition of the training need in terms of set of related training objectives.**

**In essence, this specification consists of a traslation of the discrepancies between required and available skills into a set of objective skills test that, when successfully passed provide guarantees that trainees will be able to**

### 2.3.5 Conclusions and Training Insights

The main purpose of TNA is to develop effectiveness of training program with a deep mission/aim and task analysis: one of the themes that emerged is the wide variety of methodologies employed. Most analysis had as goal elaboration of training objectives with respect to performance, conditions and standards criteria.

In most cases training needs analysis is derived from the current performance capability and the performance requirements. This is usually derived from interviews, questionnaire and review of training existing documents and procedures.



## **2.4 TRAINING PROGRAMME DESIGN**

The Systematic Approach to Training adopted within the OPTIMUS is a methodology that comprises a step wise procedure for the specification of training program requirements.

This methodology is directly focused on the specification of training program for simulators and is more restricted in scope than other SAT methodologies

During Training Needs Analysis (TNA) the training need is specified in terms of a set of related training objectives that specifies the desired outcomes of the training programme, TNA is a fundamental step for designing effective training programme: determine to a large extent effectiveness and efficiency of the overall training programme and is able to specify too the entry level of prospective trainees.

Again, much of the effectiveness and efficiency of training programme depends on the comprehensiveness and specificity of this information.

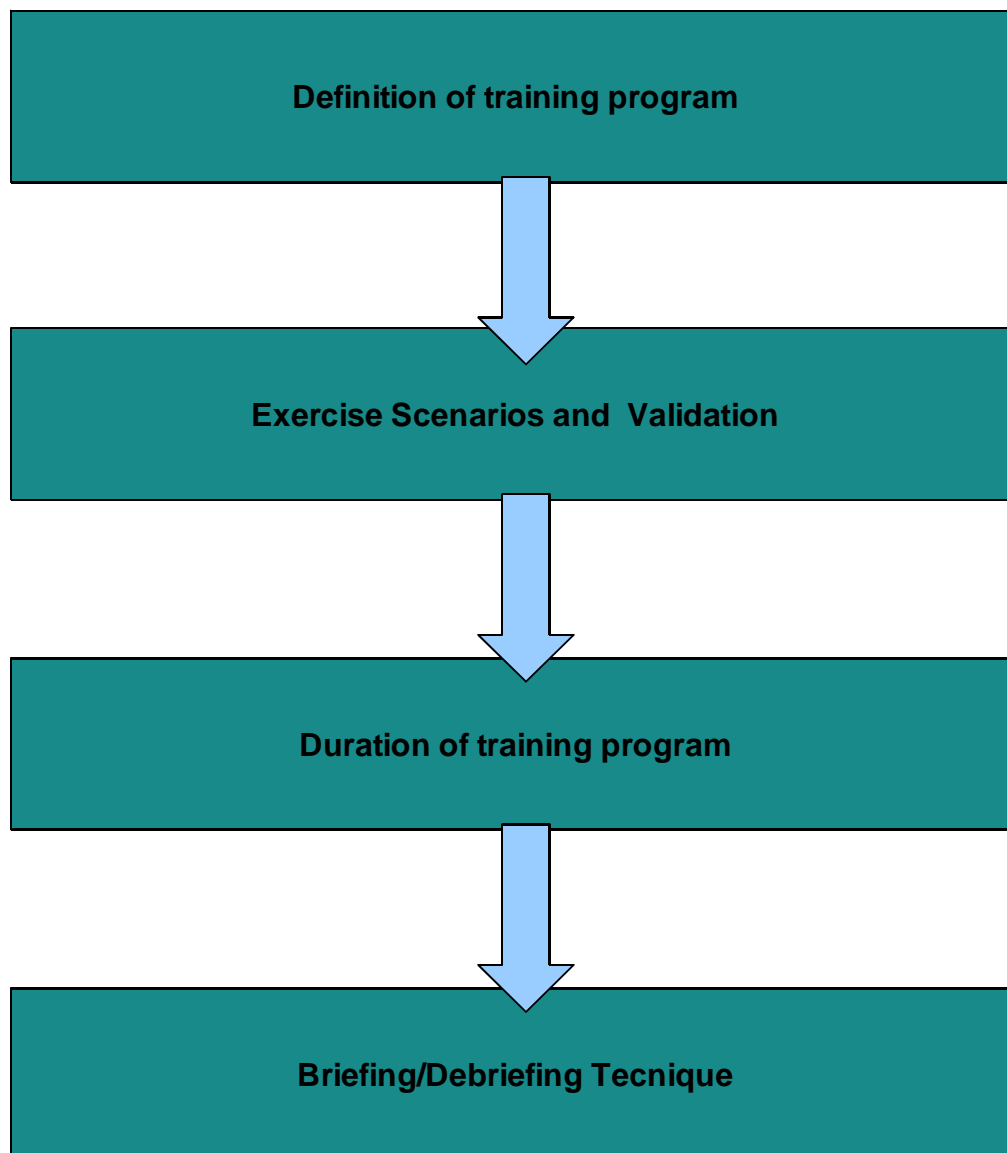
Shortly, compromises have to be made and two extreme strategies can be distinguished: what one would consider optimal and only afterwards look at what is feasible with environmental constraints. (number of instructor, availability of simulator etc.). Of course both strategies represent extremes on a continuum that ranges from exclusively constraints driven: there maybe more than one way to meet a particular training need.

In practice **Training Programme Design (TPD)** is a process during which training programme requirements are gradually **elaborated in a top down methodology**.

The dominant training philosophy in simulation based training is to train as on the job experience. The way in which training is organised should correspond as closely

as possible to operational practices, and a very important role is played by Subject Matter Experts (SME).

The general idea is that SME is the best training expert but operational expertise is not training expertise. In practice in some cases the responsibility of designing, delivering and evaluating training is assigned indiscriminately to SME. What is needed is a framework that enables mapping of these generic concepts and findings in issues relevant for Simulation Based Training design.



## 2.4.1 Use of simulation devices in Training Programme

Mere possession of a port training simulator or other training device and the presence of experts as instructors do not guarantee the effective use of simulation or effective learning. The presence of specialized features, such as physical motion platforms and high-fidelity graphic images, do not in themselves guarantee a relevant and meaningful training experience.

To be effective, **simulator resources** must be matched to **instructional objectives**.

If simulation is relevant to training objectives, then the type and level of simulation, including fidelity requirements, need to be determined.

The way a simulator is treated is important in creating a perception of reality among trainees. If the instructional staff treats a simulator as if it were a port crane and the simulator environment as real operating conditions, then the trainees are more likely to treat the experience as "real."

In creating the illusion of reality for a limited-task or higher-level simulator, attention needs to be given to accuracy requirements for the mathematical models that drive the simulation device.

No quantitative research was identified that would establish the relative merits of different approaches to port training and the types of training offered.

There is, however, a research basis that supports the application of different levels of simulation to achieve certain training objectives. Instructors reported that the degree to which a participant is familiar with the training media affects the media's relative value with respect to individual learning.

Media familiarity also influences individual performance during a simulation.

Just as in real life, a port operator becomes more confident in his or her operating performance of a simulator as his or her familiarity with operating characteristics and specific operating conditions increases.

The instructional and training value of all port and marine simulator-based training media are also affected by the nature and form of instruction, including the operational training scenarios.

## 2.4.2. The place of simulators in the Training Curriculum

Simulators are used to train a wide variety of tasks and at initial, intermediate and advanced levels including refresher training that we identify like skill retention problem.

- **Initial training** , i.e. acquiring basic knowledge of training simple procedures, is usually provided by instructors in a classroom or a briefing or by the study of textbooks. In case of Simulation Based Training, trainees may go to the simulator cockpit with instructions indicating the function of different buttons. Initial instruction is rarely supported by a full task simulator but part task simulators are used for initial training in many programs in which many different subtasks have to be trained and reduce complexity of high level profiles. In the early stages of learning, the trainees have to learn how to perform the components of each task and to learn a sequence of actions
- **Intermediate level.** Simulators are sometimes used in the middle phases of training or for training a new task to experienced trainees. Often the training program starts with theory taught in the classroom followed by practice with the simulator. Normally trainees go to field exercise to consolidate acquired new skills in a more realistic setting. After they may go to operational unit to directly observe the performance of their future task or job.
- **Advanced level.** In many simulation devices are available scenarios at different level of difficulty and complexity. Especially when the task to be learned is complex, the most desirable way would to be train the part of the task until they have been mastered, raising the complexity gradually during training. Practicing a certain task in a large variety of situations, for instance

different scenarios, is a suitable training method for more experienced trainees and for refresher training of already acquired skills.

### 2.4.3. Defining the Training Program

In this step an outline of the training program is constructed based upon the training objectives and the characteristics of the target group of trainees

A complete and effective simulator-based training course curriculum will typically include information on the following:

- overall course objectives,
- characterization of course participants and numbers,
- characterization of participant educational and professional backgrounds,
- course structure,
- course timetable,
- individual simulation exercise planning sessions,
- individual simulator exercises and their content,
- individual exercise objectives,
- instructions to staff on the methodology of simulation exercises and subsequent debriefings
- method of evaluating participants, as applicable.

The specification of training activities is aimed of those activities that should be performed by the trainee to achieve the training objectives in efficient manner.

Training activities specify what trainees actually have to do in order to learn and should be distinguished from operational activities. Many Training activities are aimed at achieving intermediate skills or skill level and may never occur under operational conditions, training activities are normally simplifications or adaptations of operational tasks.

There are several good reasons for separating the specification of training objectives from the specification of training activities: training Objectives specifies standards of performance that are to be acquired but do not specify how these standards of performance are to be achieved.

Generally, larger the gap between criterion level and entry level, the larger the difference between training activity and operational activities

The specification of training activities is one of the most difficult steps in the design of a training program, for each training objective, one or more training activity will be specified.

Towards the end of training training activities may approach operational activities.

## 2.4.4 Exercise Scenarios and validation

In this step exercises are specified that will induce the trainees to execute training activities and to attain corresponding training objectives.

The training scenario constitutes the environment in which training activities are to be executed. The design of training scenario is an important determinant of training effectiveness over and above how the training activities and the simulation capabilities of the training simulator have been specified.

For instance, given the same training activities and simulation capabilities, transfer maybe positive or negative simply by designing good or negative training scenarios.

Typically a training scenario is run as part of a training session and is proceeded by a briefing and followed by a debriefing. During briefing the trainee is allocated his training assignment, in addition to training assignment the behavior of the trainee during the scenario is determined by the appearance and by events that occur.

In the following, the issue related to the design and composition of training scenario are discussed

These are the most important elements and components to be analyzed in the development of simulation based training scenario.

In practice the design of training scenarios is the responsibility of instructors or Subject Matter experts and scenarios must be based on training objectives derived from task analysis and their operational output like training activities

It is obvious that training scenario have important implications for simulator requirements, they should be the primary drivers of simulator specifications.

Usually, the design of training scenarios is determined by the technical possibilities of the simulation device, and the scenario are simplified or adapted versions of real operational scenarios.

Typically, a limited set of basic scenario variants are employed, these variants may be modified during scenario execution to adapt training to the performance and the level of evolution of the trainee population.

Training scenarios are scheduled in terms of training sessions which have often a fixed duration. Most simulator sessions require a high level of concentration and this means that training sessions cannot last for many hours. Also, depending upon the complexity and the difficulty of managing the scenario, during scenario execution instructors may be assigned exclusively to the duty of managing or participating in the scenario.

Simulation Scenario are usually presented in a fixed order, from easy to difficult, and a more complex scenario is presented when the instructor thinks that the trainees have mastered the procedures taught in simpler ones

The following factors should be taken into account when designing these scenarios:

- 1) Type of simulator (e.g., special task, full-mission);
- 2) Geographical database;
- 3) Mathematical model and, to the degree relevant to training objectives, the model's fidelity with respect to manoeuvrability in restricted shallow water with small under keel clearances;
- 4) Type and structure of exercise scenario required to achieve the exercise objectives;
- 5) Exercise length;
- 6) Method of briefing and debriefing;
- 7) Cost effectiveness;
- 8) Level of fidelity and accuracy needed to support training objectives
- 9) Validation requirements.

Scenario creation is crucial to optimizing the **training value of individual exercises**. For these reasons we supply a step by step guide to develop and evaluate scenarios on simulation devices in the last section of these guidelines and methodologies.

Simply creating a realistic scenario does not necessarily result in operating conditions that will evoke desired student responses.

Once designed, an exercise scenario must be validated.

Validation is necessary to avoid variations in the scenarios that could adversely affect training objectives or provide inaccurate information and therefore contribute to human error during real operations.

Care must be taken to ensure that relevant cues are present. In cases where individuals are being prepared for ship handling on specific waterways or vessels, higher levels of visual scene fidelity and trajectory prediction accuracy are indicated.

These factors are especially important in operating conditions involving restricted shallow water with small under keel clearances.

It can be an advantage for instructors to visit and familiarize themselves with the real geographical area they are simulating. A visit and local knowledge also help instructors incorporate appropriate visual cues and local operating procedures.

The instructor checks if the exercise can be concluded in a way that is relevant to exercise objectives and if the scenario can achieve en routed exercise objectives.

The operational result may be successful or unsuccessful, as long as training objectives are satisfied.

Only after this point the scenario can be used with confidence to effectively satisfy training objectives.

There is no standard methodology for validating exercise scenarios. The instructor or instructional staff generally performs this function subjectively, sometimes in coordination and consultation with representatives of organizations sponsoring the training

## 2.4.5 Duration of the Training Program

We found no studies of the optimum length of simulator training time or of the optimum balance among lecture, simulator operation, and review of performance in maritime training.

Conceptually,

The duration of the course needs to be synchronized with the curricula and learning patterns to support overall training objectives.

This approach may or may not be cost effective.

Most existing simulator-based training courses last between one and two working weeks.

This decision may be due as much to commercial constraints of existing simulator-based training as it is to requirements of the training itself.

Other factors that may affect simulator training time include:

- the relatively high front-end cost of intensive simulation based training compared with the low direct cost of on-the-job learning,
- dock operators or shipping companies have limited resources available for training
- some prospective trainees may be unwilling to devote personal time to training.

Short courses typically compress course content, which may be a disadvantage from the perspective of learning and transfer effectiveness. Although port workers can be

exposed to training scenarios that might take years to experience during actual operations, compressed courses provide little opportunity to contemplate results of individual training sessions.

This lack of time to reflect may be especially significant for individuals who have limited experience or are unaccustomed to Simulation based training media. Conducting training with the same content and actual training time but over a somewhat longer period provides time for students to contemplate results and plan for subsequent training.

An alternative method might be to divide course content equivalent to five days of actual training time into training modules performed one day per week over five weeks or more.

## 2.4.6 Distinction between briefing and debriefing

Within the context of training session, instructional activities can be distinguished in what occur prior to and after scenario execution.

Briefing and debriefing are an important issue in design of instruction one important question is how to combine it in optimal way.

**Briefing** aims to activate prior knowledge and prepare trainees to execute training activities

**Debriefing** aims to evaluate results in terms of training objectives and consolidate acquired knowledge

### 2.4.6.1 Briefing

It is generally assumed that providing trainees with advance information aids subsequent training activities.

Briefing may contain:

- information about the position of the lesson or scenario within the overall training programme.
- relevant learning history
- training assignment which should include a statement of training objectives and training activities.
- composition of the scenario

- information about the way in which performance will be assessed

The way in leading briefing technique depends on type of skills to be learned.

The training of *psycho motor skills* involves presentation of more dynamic and complex types of information: for these types of skills non verbal briefing formats are generally most effective.

Demonstrations can also be carried out using films in which task performance is shown or better with **a simulation session**: in this way trainees learn by **observing and imitating another performance**

For the training of *cognitive skills* the application of rules and heuristics briefings are usually delivered verbally as these skills are difficult to visualize or demonstrate

#### **2.4.6.2 Debriefing**

The final and particularly important part of design each training session is the debriefing, which takes place once the simulator exercise is concluded, successfully or unsuccessfully.

At this point in the program, lessons of the actual exercise are reinforced, and the trainee is reminded of the exercise objectives and informed of any additional objectives that were not previously divulged.

**The simulator** could be an **effective tool in the debriefing**.

The ability to record and playback a scenario and to analyse the actions and judgements of the bridge team can assist in assessing team and individual performance.

The debriefing can be led by the instructor or by the trainees themselves with the instructor acting as a "facilitator." A debriefing, for example, is better led by the instructor, whose experience and firm hand will keep the session "on course". A

team management course, on the other hand, would probably benefit from the facilitator approach because of the general experience and interactions of a given group.

Deciding which method to use should be based on the trainee's level, experience, cultural and ethnic background, and the course type. Language limitations may also have to be taken into account.

To apply the debriefing method with a facilitator, one or more trainees are delegated to the simulator exercise to observe the actions of their colleagues. This observer will open the debriefing by examining and commenting on two questions: what went right and what could be improved?

The role of the facilitator or instructor is to allow students, through their discussions, to discover why some things went right and others went wrong. The observer's comments can be recorded for further discussion by group members. The facilitator must be free to criticize and focus attention on lessons learned.

Each member of the student team may then be asked to comment before the facilitator or instructor summarizes the session.

Using such a technique for debriefing means that the instructor provides little direct advice during the session. Criticisms are made by group peers and are thus often more readily accepted. Trainees control the discussion and maintain their own defined reference boundaries. This method encourages trainees to draw their own conclusions and assess their own performance, strengths, and weaknesses. Experience has demonstrated that this approach is most effective if debriefing rules are established at the beginning of the course.

Advantages of group discussion include:

- discussion stimulates critical thought,
- trainees learn to substantiate their statements

- trainees learn to systematize their thoughts.

During group discussions, the facilitator must avoid discussions that become too time consuming,

- misdirection of group discussions,
- session domination by a few trainees,
- social tensions
- animosity among participants.

## 2.4.7 Training Program Design Outputs

The output of TPD is a specification of prospective training programme. During training program design takes place the translation of more or less abstract training objectives into concrete training behavior.

The main steps are outlined below.

### *Definition of training program*

An outline of the training program is constructed based upon the training objectives and the characteristics of the target group of trainees. This step normally includes

- sequencing of training objectives
- allocation of different training media with particular attention to simulation devices
- construction of evaluation plan
- specification of training activities, what the learner is going do in order to learn.

### *Scenario design and validation*

In this step exercises are specified that will induce the trainees to execute training activities. The focus is on those parts of training that will take place in a future simulator. Scenarios provide one of the main inputs for specifying the requirements of training simulator to be procured or developed.

### *Duration of training program*

In this step the type and timing of instructional support that might be necessary before during and after execution of the training scenario is specified

### *Briefing and debriefing technique*

In this step are specified the briefing and almost debriefing technique that are functionally linked to use of simulation training devices

Shortly Training Program Design TPD is a ordered sequence of these steps.

### **Training Objectives from TNA phase**

### **Training program and Training activities**

### **Defintion of exercise scenarios and validation**

### **Training duration**

### **Associated instructional specifications**

## **2.5 SKILL RETENTION**

Skill retention is the degree to which performance is maintained in absence of training and experience relative to the performance at the end of training.

Learning is most often associated with the initial phase of acquiring a task or a skill whereas retention relates more specifically to the ability of reproduce an acquired skill after a period of non performance.

For several decades, researchers have been interested in the measurement of skill retention.

Although numerous theoretical approaches have proposed there is no still accepted method of measuring the rate of skill decay over time.

## 2.5.1 Importance of skill retention measurement

The period between the completion of training and subsequent performance of the trained skill is conventionally referred to as the retention interval.

Significant decay of skill during a retention interval before it is required in operation is obviously problematic. Adequate skill retention is potentially key criterion of training program success. Skills in which retention is of particular importance are those in which there may be long intervals between training and operational intervals or between one performance and the next.

These include skills that are used only in emergencies and other rare situations

The problem of skill retention and loss is of particular concerns in port sector for a number of reasons:

- operational conditions often demand reliable rapid and accurate task performance under stress
- the increasing level of automation of tasks required constant operator involvement can lead a degradation of skills through lack of practice
- for the relatively expensive of most port sector training the failure of operators to retain skills can have a considerable financial implications.

## 2.5.2 Requirements for skills retention measurement

The degree of competence to which an acquired skill is retained through the passage of time, is called skill retention.

The curve depicting the extent of material remembered, as a time variable starting at the end of the acquisition process, is called the retention curve or the forgetting curve. Some of the conventions regarding relearning of complex tasks are well known, especially those relating to the retention curve.

The agreed assumptions taken from Rose and Wheaton (1984) are:

- skills tend to decay with the passage of time;
- using appropriate retraining increases the skill of performance to the same original level;
- the relearning time duration is shorter than the original learning period;
- the first minutes of retraining are important (the “warming up” phenomenon);
- long intervals between retraining demand longer relearning processes;
- procedural skills demand longer practice time than psycho-motor skills;
- automatic skills are better retained than controlled skills.

Another aspect, which was tested in the last decade, is the relationship between learning, forgetting and relearning as elements of one process.

In two different laboratory experiments similar results were reached.

Bailey (1989) simulated assembly/disassembly tasks.

His main findings were that forgetting is a function of the amount learned and the break duration, but not of the learning rate.

Shtub and Arzy (1997) confirmed the laboratory tests. In this analysis of the skill retention subject, it is appropriate to focus on two relevant variables: port worker skill retention and retraining with simulator.

A considerable number of studies on retraining and skill retention focus on the work environment.

This is due to the fact that many tasks are of a complex nature, requiring high levels of skill on the part of their operators.

Ordinarily, the operators do not perform the task often and, therefore, refresher training is required in order to achieve skill retention.

For example, the examination of the skill performance of complex skill profile like helicopter pilots indicates that there is a critical decline in their skills after six months of no flying.

Similar results were found in many studies concerning retention aspects of tasks but most of them are not generally known because they are published only in research reports that are available only for a framework.

**Using simulators for task learning is common. However, using it for retraining is less common.**

There are only a few articles about simulator training method concerning skill retention. This present example also took advantage of the opportunity to conduct a controlled field experiment in a military unit, examining refresher training of reserve soldiers operating a complex system as a team.

### 2.5.3 Case study

The Israel Defence Force maintains an operational unit for Electronic Warfare.

The participants in this study were 53 reservists of this unit, undergoing refresher training using a partial simulator.

Each training session consisted of three exercises called “links”, lasting 30 minutes each.

A team of four operators is needed for each link. Ordinarily, each reservist does such a retraining session about once a month. During each link an experienced officer evaluates each operator’s performance.

The operators’ ages were between 22 and 47. As a result of their past experience these operators have been very well acquainted with the system and the system’s environment. It is important to add that in general the Operator’s Level of Performance (OLP) is evaluated as being “very high”.

A pilot study was conducted aimed at examining and verifying successfully the various basic assumptions regarding the reserve operators and their professional level. The pilot study also served to find the suitability of the designed questionnaires and the manner in which they were completed by the evaluators.

One questionnaire tested psycho-motor (Ps’) behaviour and the other tested procedural (Pr’) behaviours. Another delineation was taken from the same two questionnaires expressing the automatic (At’) and the controlled (Co’) behaviours.

The operators were divided into three groups of 16 each according to the time duration between retraining (training intervals).

- **The first group had training intervals of one month (as usual).**

- **The second group had two-month intervals**
- **The third group had three-month intervals.**

Sampled intervals of six months were examined on five operators

Special attention was given to avoid any intermediate work with the system for the purpose such as real operational work. The OLP was examined after regular training and once more after the next interval (one, two or three months).

Each time evaluations were made and scores were given after each link, with a total of three evaluations taken.

The main goal of this study was to examine **the relations between relearning and skill retention concerning complex tasks**, especially by identifying **the parameter** affecting the required **time-duration between retraining** (training intervals).

The longer the training interval between the sessions, the lower the measured OLP after the next first part of the session (the first link). These findings received stronger support when we observe the OLP after a six-month period without training.

The results were what was expected.

Observations of the psycho motor and the procedural behaviour of the operators show the same characteristics we had already known from the survey of the literature.

**Forgetting** is faster when concerned with **procedural skills** and **slower** concerning **psycho-motor skills**.

That conclusion leads to our perceived need of more intensive training of procedural skills, which helps balance between the two dimensional skills.

Another possible solution that is apparent with operational tasks is using written procedures. It guarantees the memorization of the process in the right order in order to execute the tasks properly, especially in emergency cases.

The disadvantage of this method is that on occasions the operator does not have sufficient time to follow the lists.

The ability to restore the operators' performance to a given pre-determined level at the end of each training cycle (according to the different training intervals) is both interesting and important because of its results and implications. We can observe that there is a big difference between training intervals of one or two months versus three months.

**After three months without training, three links are not sufficient to bring the operator back to the required level.**

Whereas the two-month interval had the same effect as the one-month interval achieving a full restoration of skills.

## 2.5.4 . Conclusions

The analysed case study reaffirms two aspects:

1. There is a need to put the emphasis on the procedural and the controlled elements of the task in comparison with the psycho motor and automatic elements (using written procedures is recommended as well).
2. A partial simulator could be suitable for refresher training of a complex task (with functional similarity to the task's environment). This finding also supports the use of a partial simulator for retraining tasks.

This field study reaffirms the current perception, seeing learning, forgetting and relearning as elements of one continuous learning process.

The elaborated model connects between forgetting and relearning, while emphasizing the time-duration between the retraining sessions.

Another important recommendation emanating from the study requires careful prior planning for retraining of complex tasks.

That planning must be an integral part of the instructional task analysis and our opinion is that the results of this study are very interesting and useful for use of simulation devices in skill retention for port operators.

For the OPTIMUS Project the problem of skill retention seems to be very important and the use of simulation devices for refresher training sessions maybe very useful.

## 2 SECTION 3 - Evaluation

### 3.1 INTRODUCTION

A fundamental element of the OPTIMUS Process is continual analysis and improvement of the training program. There is always a concern about the effectiveness of a new or even existing training program. Essentially, the issue is whether trainees learn what is necessary for on-the-job performance: the training effectiveness is generally based on whether trainees pass the course and **perform successfully on the job.**

There is, for example, the question of short-term versus long-term effects, an issue of particular concern for intensive courses of short duration. Recent evidence suggests that many technical training programs teach marginally relevant skills, and graduates of those courses have to be retrained when they are placed in an operational environment. It is not uncommon to hear complaints that new graduates from a training course do not have the necessary operational skills and must be retrained on the job.

Satisfactory performance **on an examination within a course structure** does not ensure that **the training was effective.**

Tests are generally oriented toward the material taught in the course and may be no more relevant than the course itself. In addition, formal testing may fail to capture subtle but critical aspects of operational skills.

Typically, formal tests examine those aspects that are easy to frame and evaluate by standard grading methods.

In complex and diverse tasks, formal testing rarely succeeds in evaluating the depth of knowledge and skill needed for operational performance of a multiplicity of tasks while under stress.

### **3.1.1 Need of Standards for professional profiles and training packages**

With a few notable exceptions (for instance international welding federation) there are no many professional, industry, or national guidelines, standards, or requirements for certifying professional profiles and instructors, either through professional organizations, port and shipping industry, education, training programs, or government agencies.

The Australian National Training Authority is a notable exception: in logistic and port sector authorised few qualified training providers at national level.

#### **Authorized Training Provider in port sector:**

- **TDT Australia**
- **P&O Ports**

We could find two simple Examples of Standardised Training Package at national level composed by standardized units for the port sector operators, for instance

Unit TDT D1097A Operate a forklift – TDT Australia

Unit ZPOAK02A Operate e light forklift – P&O ports

### 3.1.1.1 Unit Standardised Model

**Unit title:** Title of the Unit.

**Unit field:** Field of application of the unit.

**Unit description:** Short description of the unit.

**Elements:** describe the essential outcomes of a unit of competency.

**Performance criteria:** describe the required performance needed to demonstrate achievement of the element.

**Range of variables:** The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance.

**Evidence guide:** The evidence guide provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and skills.

**Key competency:** The Key Competencies represent generic skills considered necessary for effective participation by an individual in the workplace.

**Performance Level 1** - at this level, you are required to undertake tasks effectively

**Performance Level 2** - at this level, you are required to manage tasks

**Performance Level 3** - at this level, you are required to use concepts for evaluating and reshaping tasks

#### An example Unit TDT D1097A Operate a forklift – TDT

Unit title:

OPERATE a FORKLIFT

Unit field:

“D” Load Handling

Unit description:

This unit involves the skills and knowledge required to operate a forklift, including checking forklift condition, driving the forklift to fulfil operational requirements, monitoring site conditions and monitoring and maintaining forklift performance.

Each recognized and standardized unit is composed by elements, for instance.

#### Elements 1:

##### **Check forklift condition**

- Condition of forklift is checked for compliance with OHS and workplace requirements for warning devices, manufacturer's specifications and the nature of the load shifting task
- Attachments are checked to ensure appropriate adjustment and operation
- Mirrors and seats are adjusted for safe operation by the driver
- Log books are checked and appropriate workplace documentation is completed in accordance with workplace requirements

#### Elements 2:

##### **Drive the forklift**

- Forklift is started, steered, manoeuvred, positioned and stopped in accordance with regulations and manufacturer's instructions
- Engine power is managed to ensure efficiency and performance and to minimise engine and gear damage
- Operational hazards are identified and/or anticipated and avoided or controlled through defensive driving and appropriate hazard control techniques
- Forklift is driven in reverse, maintaining visibility and achieving accurate positioning

- The forklift is parked, shut down and secured in accordance with manufacturer's specifications, regulations and workplace procedures

#### Elements 3:

##### **Operate a forklift to handle loads**

- The lifting task to be undertaken is appropriately planned and the correct lifting truck and attachments are selected
- The load is lifted, carried, lowered and set down in accordance with OHS legislation, manufacturer's specifications and company procedures

#### Elements 4:

##### **Monitor site conditions**

- When selecting the most efficient route, hazards and traffic flow are identified and appropriate adjustments are made
- Site conditions are assessed to enable safe operations and to ensure no injury to people or damage to property, equipment, loads or facilities occur

#### Elements 5:

##### **Monitor and maintain forklift performance**

- Performance and efficiency of vehicle operation is monitored during use
- Defective/irregular performance and malfunctions reported to relevant personnel
- Forklift records are maintained/updated in accordance with workplace procedures and legislative requirements

**This level of standardisation of ANTA training packages represent the optimal level to introduce a simulation tool in training and permit the optimisation of whole training process.**

**The whole unit is described in Appendix part of this report.**

### 3.1.2. Main types of Training measurement: subjective and objective

Training performance measures should fulfil the following roles:

- Monitoring progress of trainee
- indicating sources of learning difficulties
- providing feedback to instructor and trainee
- measuring transfer of training and retention of skills
- evaluating training methods

Both subjective and objective measures have a role in training programmes.

**Subjective measures** represent the opinion of the trainee or of a subject matter expert such as an instructor and may be based upon a rating scale. Subjective measures tend to be easier to use and less expensive to obtain specific measures

**Objective measures** are collected directly from performance such as deviation from required track.

These measures might best be met by assigning experienced practitioners to evaluate performance.

These evaluators should be carefully selected and trained, remain independent of the conduct of training - to avoid "ownership" in the training product or interpersonal relationships that could influence their evaluations - and be experienced enough to judge the effectiveness of operational performance.

In addition, they must remain familiar with current practice and, ideally, should periodically cycle through line operations. It is probably not desirable for the evaluators to be totally independent from organizational goals and policy.

The assumption is that experienced practitioners can recognize how well such goals are being satisfied and are sensitive to tradeoffs that are sometimes essential in the pursuit of diverse goals.

### 3.1.3 Main types of Training measurement: Informal and formal Evaluation

The most common type of evaluation is **informal**.

These evaluations, most of which are implicit, are routinely conducted as an integral part of simulator-based training courses. They are typically conducted on an ad hoc basis and are usually not written. The most common form of informal evaluation is the undocumented debriefing of an exercise by an instructor or instructors.

These routine, ad hoc evaluations are used to adjust exercise content and timing and to guide trainees toward achieving planned learning objectives. Instructors also evaluate the results of training to help improve course content and methodology.

Trainees also conduct evaluations.

They continuously evaluate the degree to which a course is moving them toward meeting their personal or professional development objectives.

Similarly, the sponsors of trainees make implicit evaluations on a course's value to their organizational objectives.

To be effective, **formal** evaluations or assessments must have standardized and structured monitoring and must include a critique of individual performance in a range of exercises appropriate to the instructional or licensing objectives or criteria. Formal evaluations or assessments must be consistent in method, timing, and responsibility from class to class or test to test, so that results can be compared and contrasted with a high degree of reliability.

### 3.2 SYSTEM EVALUATION MODELS SUITABLE FOR SIMULATION BASED TRAINING

The best known and first training methodology for evaluations is Donald Kirkpatrick's Four Level Evaluation Model. These are general tools that are suitable for port sector and simulation based training

The four-levels of evaluation consist of:

- **Reaction** - how the learners react to the learning process
- **Learning** - the extent to which the learners gain knowledge and skills
- **Performance (behaviour)** - capability to perform the learned skills while on the job
- **Results (impact)** - includes such items as efficiency etc.

A further level of evaluation is based on **ROI index**.

**Level 1: Reaction** how the learners react to the learning process

**Level 2: Learning** the extent to which the learners gain knowledge and skills

**Level 3: Behaviour** capability to perform the learned skills

**Level 4: Results** (impact) - includes such items as efficiency, moral, etc

**Level 5: R.O.I.** Return on investment

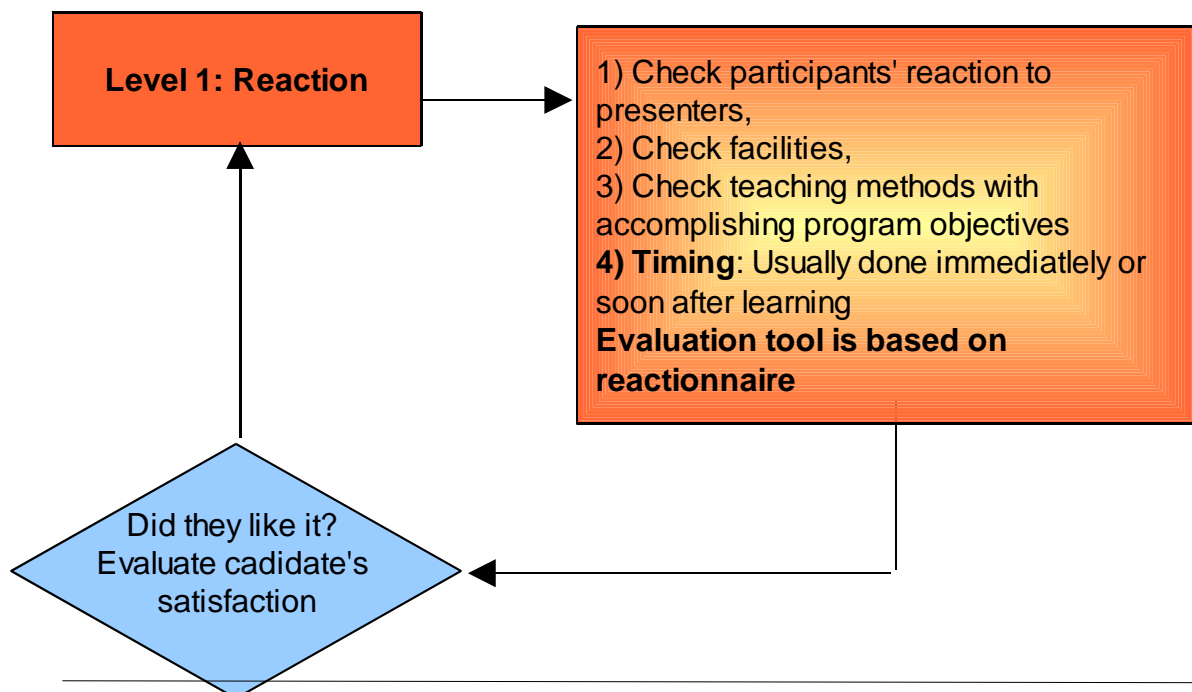
### 3.2.1 Level one. Reaction

Evaluation at this level measures how the learners react to the training.

This level is often measured with attitude questionnaires that are passed out after most training classes.

**This level measures: the learner's perception (reaction) of the course.**

Learners are often keenly aware of what they need to know to accomplish a task. If the training program fails to satisfy their needs, a determination should be made as to whether it's the fault of the program design or delivery. This level is not indicative of the training's performance potential since it does not measure what new skills the learners have acquired or what they have learned that will transfer back to the working environment.



This level of evaluation is suitable for simulation based training in port sector and in the OPTIMUS Training Schema could evaluate the first two sections of training schedule and the whole training program too. For instance the cognitive part and the simulation based training.

The interest, attention and motivation of the participants are often critical to the success of any training process. People often learn better when they react positively to the learning environment by seeing the importance of it.

This is a basic level of evaluation and is suitable for Simulation based training.

When a learning package is first presented the learner has to make a decision as to whether he or she will pay attention to it. If the goal or task is judged as important and doable, then the learner is normally motivated to engage in it. However, if the task is presented as low-relevance or there is a low probability of success, then a negative effect is generated and motivation for task engagement is low.

At general level evaluators underline limited effectiveness of the Reaction evaluation level but in our opinion this is only a tool to measure satisfaction of trainee. At this level of evaluation participant responses are easy to collect but provide little information about the value of training to the organisation.

The problem is to matching the different level and tools of evaluation in an effective way to check and understand what training managers want to know.

**For this aim we recommend the development of a structured evaluation plan of all training activities that involved simulation devices.**

If the problem is to check only the satisfaction of the trainees this is the right tool.

## Evaluation tool is based on Reactionnaire

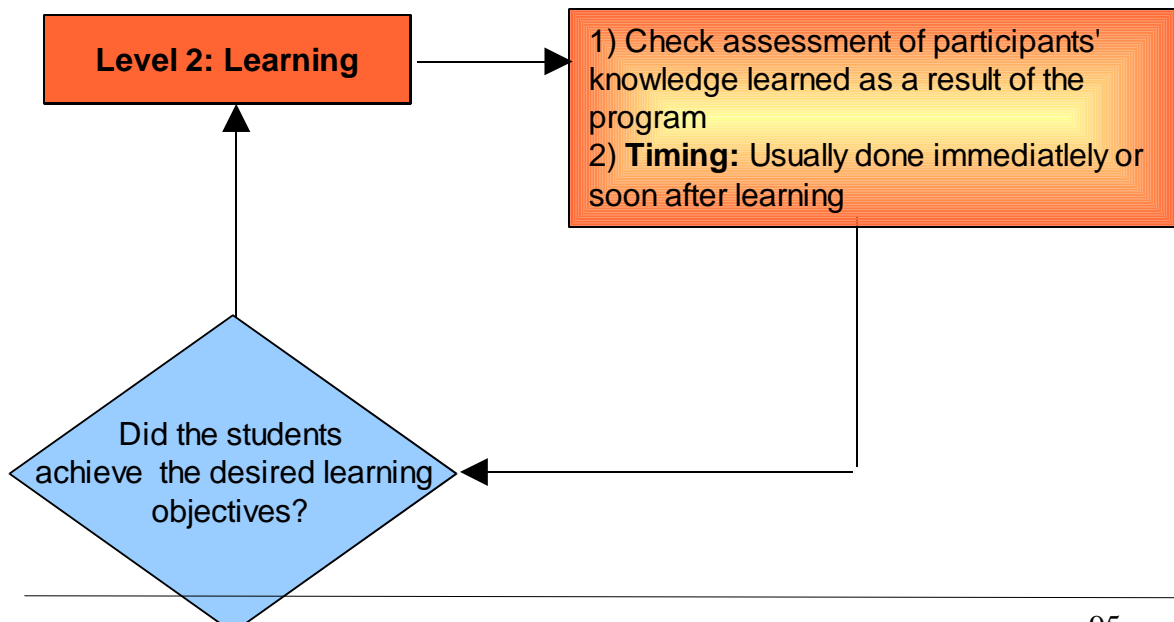
### 3.2.2 Level two. Learning

This is the extent to which participants change attitudes, improve knowledge, and increase skill as a result of participating in the learning process.

It addresses the question: **Did the participants learn anything?**

The learning evaluation requires some type of post-testing to ascertain what skills were learned during the training.

In addition, the post-testing is only valid when combined with pre-testing, so that you can differentiate between what they already knew prior to training and what they actually learned during the training program. Measuring the learning that takes place in a training program is important in order to validate the learning objectives.



Evaluating the learning that has taken place typically focuses on such questions as:

1. what knowledge was acquired?
2. what skills were developed or enhanced?
3. what attitudes were changed?

This level of evaluation is suitable for simulation based training in port sector and in the OPTIMUS Training Schema could evaluate every section of training schedule and the whole training program too

Learner assessments are created to allow a judgement to be made about the learner's capability for performance. There are two parts to this process: the gathering of information or evidence (testing the learner) and the judging of the information (what does the data represent?).

This assessment should not be confused with *evaluation*.

Assessment is about the progress and achievements of the individual learners, while evaluation is about the learning program as a whole

For the training analyst and designer, indeed, the building of the assessment helps to define what the learning must produce. For the learner, assessments are statistical instruments that often poorly correlate with the realities of performance on the job and they rate learners low on the "assumed" correlatives of the job requirements

Thus, the next level, performance or behavior, is the preferred method of assuring that the learning transfers to the job, but it is quite rarely performed.

## Evaluation tool is based on testing

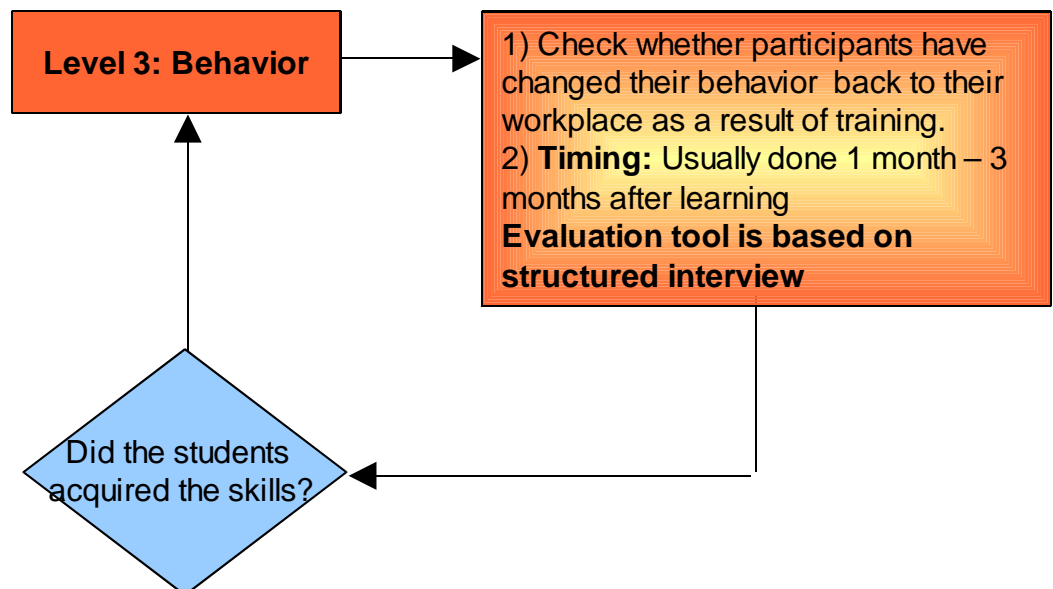
### 3.2.3 Level three. Behavior or Performance

This level of evaluation involves testing the students capabilities to perform learned skills while on the job, rather than in the classroom.

Level three evaluations can be performed formally (testing) or informally (observation). It determines if the correct performance is now occurring by answering the question, "Do people use their newly acquired learning on the job?"

In Kirkpatrick's original four-levels of evaluation, he names this level "behaviour." However, behaviour is the action that is performed, while the final result of the behaviour is the performance.

The consequence of the behaviour (performance) is what we are really after — **can the learner now perform and produce the needed results in the working environment?**



This level of evaluation is suitable for simulation based training in port sector and in the OPTIMUS Training Schema could evaluate simulation based section, on the job training section but is very helpful to evaluation of the whole training program.

It is important to measure performance because the primary purpose of training is to improve results by having the students learn new skills and knowledge and then actually applying them to the job.

Learning new skills and knowledge is no good to an organization unless the participants actually use them in their work activities.

Since level-three measurements must take place after the learners have returned to their jobs, the actual Level three measurements will typically involve someone closely involved with the learner, **such as a supervisor.**

Although it takes a greater effort to collect this data than it does to collect data during training, its value is important to the training department and organization as the data provides insight into the transfer of learning from the classroom to the work environment and the barriers encountered when attempting to implement the new techniques learned in the program.

**Evaluation tool is based on structured interview to supervisor or manager**

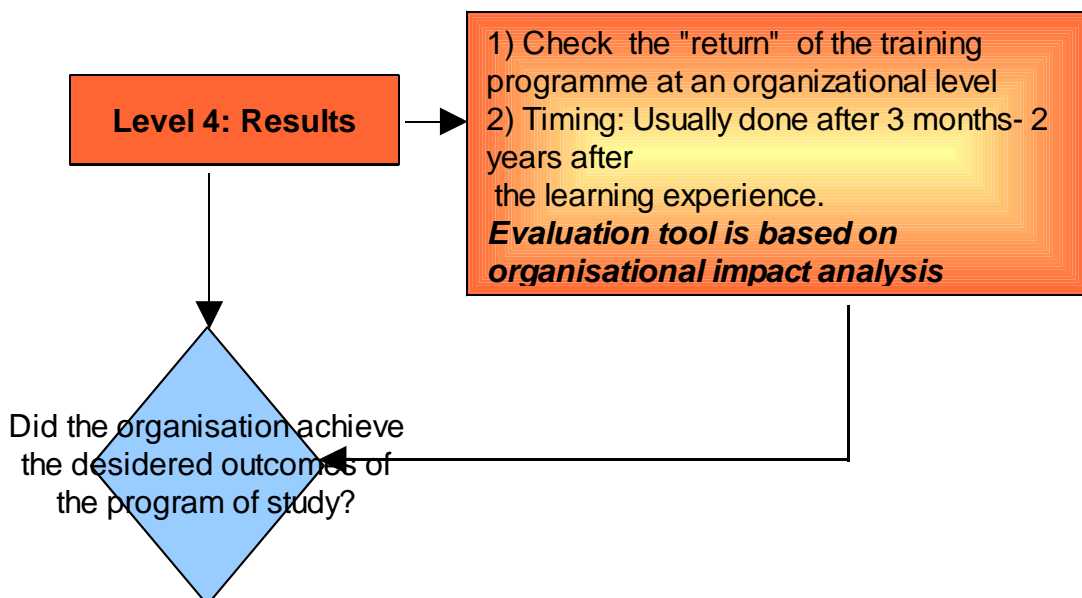
### 3.2.4. Level four. Results

This level of evaluation is one of the most complex and time spending and it measures the training program's effectiveness, that is, "What impact has the training achieved?" These impacts can include such items as monetary, efficiency, moral, teamwork, etc.

As we move from level one to level four in the scale of evaluation methods, the evaluation process becomes more difficult and time-consuming, however, the higher levels provide information that is of increasingly significant value.

At this level the information needed is most difficult to capture

Perhaps the most frequently type of measurement is level-one (Reaction) because it is the easiest to measure, yet it provides the least valuable data. Measuring results that affect the organization is considerably more difficult, thus it is conducted less frequently although it yields the most valuable information.



This level of evaluation is suitable for simulation based training in port sector and in the OPTIMUS Training Schema is very helpful and applicable to evaluation of the whole training program.

The first three-levels of Kirkpatrick's evaluation — Reaction, Learning, and Performance are largely "soft" measurements; however, decision-makers who approve such training programs, prefer results (returns or impacts).

- **Impact** informs you of the "return" the organization receives from the training. Decision-makers prefer this harder "result," although not necessarily in money value

## Evaluation tool is based on organisational impact analysis

### 3.2.5. Computing Training ROI (Return on Investment)

Accountability is a key issue for training departments as well as other business units. Consequently, the idea of being able to calculate the return on investment (ROI) of training is very important, almost in Simulator based training that normally need high investments in procurement of advanced simulation devices.

#### 3.2.5.1 Measuring the return of investment

A comprehensive evaluation of ROI only occurs at Level 5.

A thorough ROI analysis is typically conducted for only 10-20% of all training programs. The collection and analysis of data can be time consuming and expensive. Computing the ROI of simulation based training at Level 5 involves these four steps:

**(1) isolating the effects of training,**

**(2) converting these effects (benefits) into monetary values,**

**(3) calculating the costs of the training**

**(4) comparing the value of the effects to the incurred costs.**

#### 3.2.5.2 Isolating the effects of training

To determine the ROI of training you must be able to measure the changes that occur as a result of training. Consequently, you must know what the performance or level of knowledge was *before* you began the training initiative. Pre-training data measure-

ment might include frequency of errors, labour hours per unit of production or service, volume of lost sales, absentee rates, turnover rates, or survey ratings indicating customer dissatisfaction. An option to pre-training and post-training data comparisons is to **use two sample groups of employees**. One *test group* receives the training while the *control group* does not. Productivity or performance of the two groups is measured and compared.

### **3.2.5.3 Converting the effects in monetary value**

The effects, or benefits, of a training program should always be identified, qualified and converted to value. Trainees' supervisors, department or division heads, senior level executives or even the board of directors are in excellent positions to observe changes in performance or impact on the bottom line. Effects can be tangible or intangible and are frequently referred to as "hard data" and "soft data."

Hard data is quantitative, statistical, number oriented and easily translated into monetary benefits.

Soft data is qualitative and refers to intangible benefits that are subjective and thus are more difficult to measure and translate into monetary benefits.

Samples of both kinds of data are listed below.

#### **Sample "Hard" Data for Determining the Effects of Training Data**

- Productivity measures (quantity or market value)
- Quality measures (number of rejects or cost of rejects)
- Materials costs (amount per unit of production or amount of waste or scrap)
- Labour hours per unit of production
- Labour costs per unit of production

- Hours of "down time" due to equipment failure, etc.
- Absenteeism and tardiness rates
- Turnover rate
- Workers compensation claims - nature and number of injuries or illnesses, days of lost work or "light duty" work
- Number of grievances/legal claims/lawsuits
- Time required to fill vacant positions
- Time required to fill an order; resolve a complaint, etc.
- Customer satisfaction rating or index
- Number of repeat customers

### **Sample "Soft Data" Effects or Benefits of Training**

- Improved job satisfaction
- Improved teamwork
- Increased organizational commitment
- Improved succession planning
- Increased communication regarding career paths
- More clearly defined promotion opportunities

### ***3.2.5.4 Calculating the cost of training***

When calculating costs, remember to consider all indirect costs, such as staff time, use of existing materials, equipment, classrooms, etc. The term "fully loaded costs" is sometimes used to designate that the costs of a program include both direct and indirect costs.

### **Sample Training Costs**

Design and development costs

The first category of cost to be considered is the design and development of the training programme.

You will need to consider:

- internal days of design and development
- costs of external designers and developers
- other direct design and development costs (purchase of copyrights, travel, expenses, etc.)
- outright purchase of off-the-shelf materials

### **Promotional costs**

Most organisations devote effort to promoting their training programmes.

- internal days of promotional activity
- costs of external agencies
- other direct costs of promotion (posters, brochures, etc.)

### **Administration costs**

An allowance must be made for the time taken by the training department in administering the training programme.

- hours of administration required per student
- direct administration costs per student

### **Faculty costs**

These costs relates to the delivery of the training, whether this is mediated by faculty (tutors, instructors, coaches, etc.) or is self-administered (workbooks, CBT, on-line training, etc.).

- the number of students who will be going through the programme

- hours of group training
- hours of one-to-one training
- hours of self-study training
- additional faculty hours
- faculty expenses

## **Materials**

Then there's the cost of materials:

- cost per student of training materials
- license cost per student for use off-the-shelf materials

## **Facilities**

You will also need to allow for the cost of your training facilities, whether these are internal or external.

Make sure to include the rental or notional internal cost of the following:

- Simulation training rooms
- open learning / self-study rooms
- Simulators equipment used

## **Student costs**

Probably the most significant delivery cost relates to the students themselves.

When an employee goes through a training programme in work time, the organisation is not only having to pay that person's payroll costs, they are also losing the opportunity for that person to add value to the organisation.

## **Evaluation costs**

You also need to make an allowance for the time spent evaluating the training, whether this is an ROI analysis or some other method.

### **3.2.5.5 Forecasting and measuring benefits**

The financial benefits of training can not be measured in terms of student reactions, nor the amount of learning that has been achieved; not even the extent to which behaviour may have changed.

We should analyse the major categories of benefits.

#### **Labour savings**

Labour savings occur where, as a result of the training, less effort is needed to achieve current levels of output. We have to assume that savings are realised by a reduction in the amount of labour applied to a particular job.

Examples of labour savings include:

- reduced duplication of effort
- less time spent correcting mistakes
- faster access to information

#### **Productivity increases**

Productivity increases occur where, as a result of training, additional output can be achieved with the same level of effort. This implies that the organisation requires more output in this particular area.

If it does not, then it might be better to express the benefit as a cost saving.

Examples of productivity increases include:

- improved methodologies reducing the effort required
- higher levels of skill leading to faster work
- higher levels of motivation leading to increased effort

#### **Other income generation**

In some job positions, it may be possible for new income to be generated as a direct result of training. Sometimes this can be satisfactorily recorded as a productivity increase, but there will be times when a more direct and specific analysis is required.

Examples of other income include:

- a higher success rate in winning competitive pitches, leading to increased sales
- sales referrals made by non-sales staff
- new product ideas leading to successful product launches

### **3.2.5.6 Calculating return on investment**

Return on investment tells you the percentage return you have made over a specified period as a result of investing in a training programme. On the assumption that benefits will continue to accrue some time after the training, then the period that you specify is critical to the ROI figure you will obtain.

It is relatively simple to calculate return on investment:

$$\% \text{ ROI} = (\text{benefits} / \text{costs}) \times 100$$

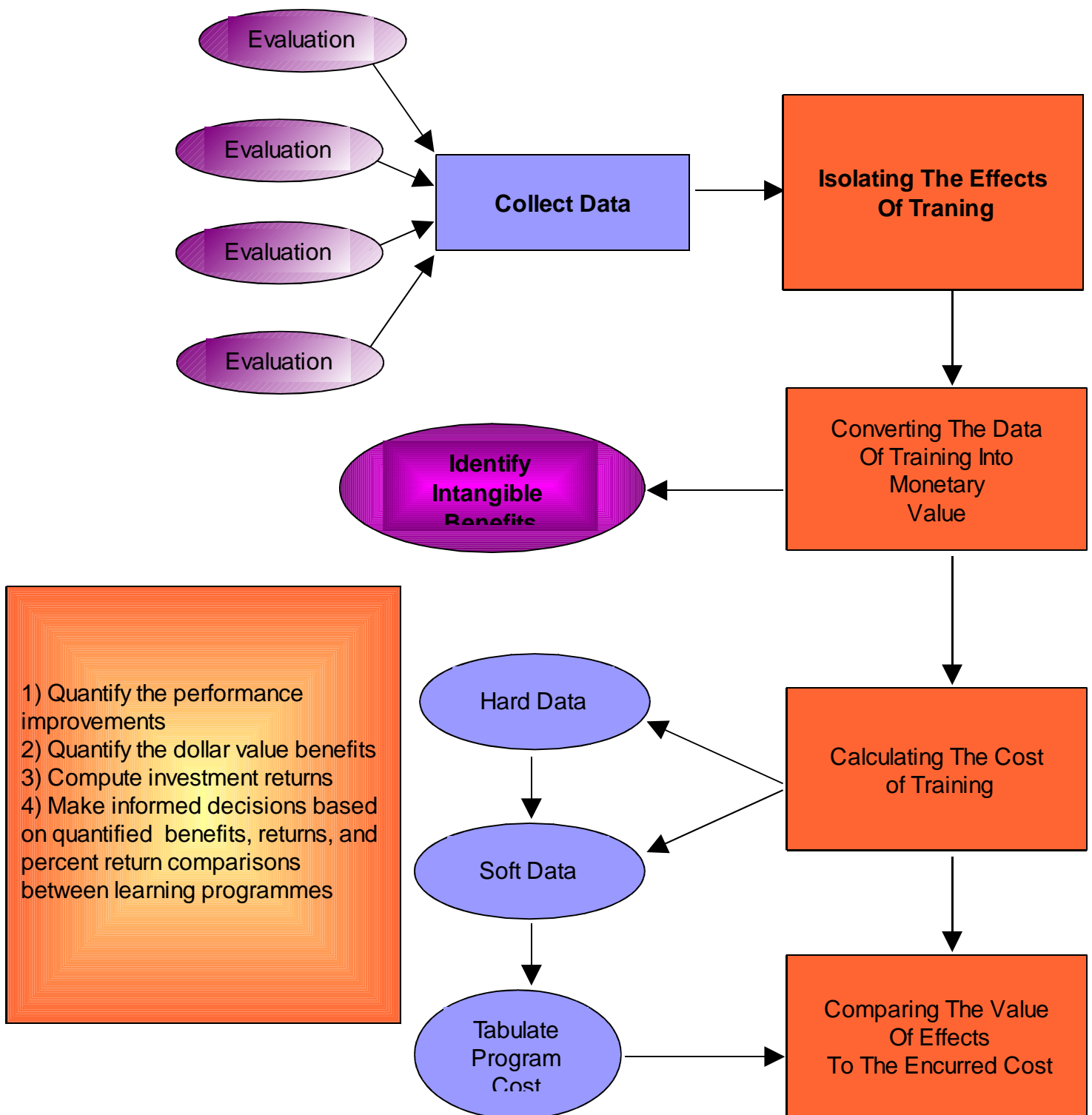
#### *Payback period*

Another way at looking at ROI, is to calculate how many months it will take before the benefits of the training match the costs and the training pays for itself. This is called the payback period:

$$\text{payback period} = \text{costs} / \text{monthly benefits}$$

Payback period is a powerful measure. If the figure is relatively low – perhaps only a few months – then management will be that much more encouraged to make the

training investment. As a measure, it also has the advantage of not requiring an arbitrary benefit period to be specified.

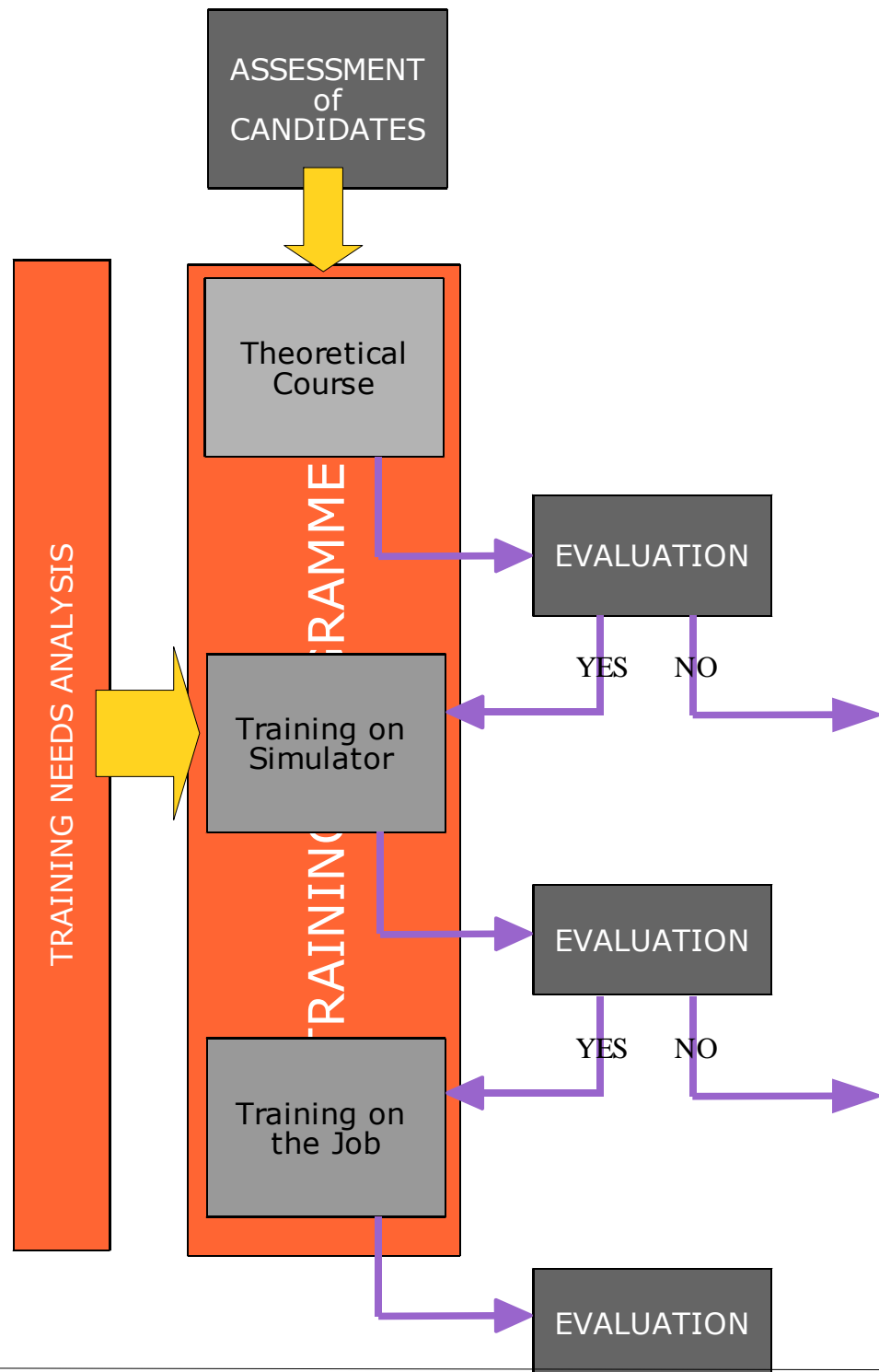


### 3.2.5.7 An example of ROI calculation

Duration of training	33 hrs
Estimated student numbers	750
Period over which benefits are calculated	12 months
<b>Costs</b>	
Design and development	£40,930
Promotion	£4,744
Administration	£12,713
Faculty	£86,250
Materials	£15,000
Facilities	£40,500
Students	£553,156
Evaluation	£872
<b>Total cost</b>	<b>£754,165</b>
<b>Benefits</b>	
Labour savings	£241,071
Productivity increases	£675,000
Other cost savings	£161,250

<b>Total benefits</b>	£1,077,321
<b>Return on investment</b>	143

### 3.2.6 OPTIMUS process and application of evaluation tools



## 3.3 CANDIDATES EVALUATION

### 3.3.1 Assessment of candidates

One of the most important steps for the development of evaluation methodology for simulation based training in the port sector is the analysis of the main tools and procedures for assessment of candidates with a particular attention to predictive validity aspects.

The systematic **use of simulation devices** could play a very important role in **assessment of candidates** for training like we could explain in further part of this guidelines and methodologies for the OPTIMUS project

In the port sector too, with the introduction of new technology the use, control and management of complex port tools and cranes have become increasingly demanding of the operator.

These systems requiring increasing levels of cognitive skills and often imposes high level of stress upon operators: moreover the training of operators for complex port crane or tools is an important cost factor.

For these reasons is therefore necessary to give high priority **to selection of candidates who will prove to be trainable.**

Use of simulator devices will be very helpful in selection of candidates to port training program for instance like crane operator.

The most common criterion of trainability is usually the trainee success, judged either by assessment at the end of training or by on the job performance.

### **3.3.1.1. Types of test**

A large variety of personnel selection procedures have been developed including interviews, psychometric test, simulator test, work sample test.

Selection test can be classified like signs or samples.

Signs are more traditional test in which inferences are drawn about the psychological characteristics needed for successful job performance.

Sample approach focuses on job task and design selection procedures that provide representative samples of the behaviour needed for successful job performance.

**Simulator test** or **work sample test** are example of **sample selection test**.

Test that allow the prediction of trainees performance particularly whether they will successfully complete their training and perform well in the operational environment, are a necessity for a successful training programme.

In our opinion trainability test and work or simulator sample are the best way to predict trainability of training program participants, obviously they may need a integration with personality test which predict the stress tolerance of the potential trainee.

### **3.3.1.2. Psychometric test**

Psychometric tests are based upon generic psychological principles or measurement theories. At general level a psychometric test is a series of questions, problems, or practical tasks that provide a measurement of aspects of somebody's personality, knowledge, ability, or experience.

There are three main categories of psychometric test:

- ability or aptitude tests
- achievement tests
- personality tests.

However, no test can ever be 100% accurate, and should be viewed more as a useful indicator than a definitive verdict on a person's skills or potential.

Tests are used in recruitment, to verify whether or not a candidate is likely to be a good fit for a job, and in employee development, and their administration and interpretation must be carried out by qualified people.

Tests are increasingly taken, scored, and interpreted with the aid of computer-based systems. A test may also be referred to as an instrument, and tests can be grouped into a test battery

### **3.3.1.3. Work samples and simulator test**

Work Sample Tests is designed to have high content validity through a close relationship with the job, simulation devices could play a very important role in this type of assessment of candidates. Work Sample tests are based on the premise that the best predictor of future behaviour is observed behaviour under similar situations. These tests require the examinees to perform tasks that are similar to those that are performed on the job.

The main advantages and disadvantages of work sample test are outlined below

#### **Advantages**

- high reliability
- high content validity since work samples are a sample of the actual

#### **Disadvantages**

- costly to administer; often can only be administered to one applicant at a time

work performed on the job

- low adverse impact
- because of their relationship to the job, these tests are typically viewed more favourable by examinees than aptitude tests
- difficult for applicants to fake job proficiency which helps to increase the relationship between score on the test and performance on the job
- Work Sample tests use equipment that is the same or substantially similar to the actual equipment used on the job
- although useful for jobs where tasks and duties can be completed in a short period of time, these tests have less ability to predict performance on jobs where tasks may take days or weeks to complete
- less able to measure aptitudes of an applicant thus restricting the test to measuring ability to perform the work sample and not more difficult tasks that may be encountered on the job

### ***3.3.1.4 Main Types of Work Sample Tests and Simulator test***

#### **Work-Sample Tests of Trainability**

The work-sample tests of trainability are suitable for untrained applicants with no previous job experience. The predictive validity of this technique is low relative to other techniques of work samples and there is evidence the validity of the instrument may attenuate over time.

#### **Work-samples**

These are tests through a period of instruction when the applicant is expected to learn tasks involved in a work sample. Applicants perform observable, job-related behaviours as predictors of criterion performance. It is not feasible to adapt certain work behaviours for testing. Work samples often are not conducive to group

administration and, therefore, were dropped from consideration because of concerns regarding test security.

### **Simulation of an Event**

These tests present the candidate with a picture of an incident along with quotations from those involved. The candidates then respond to a series of questions in which they write down the decisions they would make. The test is scored by subject matter experts.

### **Low Fidelity Simulations**

These tests present applicants with descriptions of work situations and five alternative responses for each situation. Applicants choose the responses they would most likely and least likely make in each situation.

### **3.3.1.5. Conclusions and Predictive Validity**

For the main aim of this report the assessment of candidates is the starting point of guidelines and methodologies for simulation based training in port sector. In this chapter we investigated the possible use of simulation devices in selection and assessment of candidates with a particular attention to predictive validity of all types of test and measurement that are described in this report

The results of predictive validity are sourced from different sector of activity, but the most interesting results are from military sector. These results must be compared to a criterion value, such for instance as success to complete training program or measure of job performance.

Findings in military sector are very interesting for assessment of candidates in port training at general level for work samples coefficients of predictive validity – in

application to simulation devices – are reported value from 0.45 to 0.65 in a scale comprises between 0 and 1.

Predictive validity for psychometric and aptitude tests are generally low, about 0.30.

Without doubt Psychometric test are more common than work samples or simulator test.

In our opinion, and particularly for occupations with high operational requirements like for instance container crane operator or traffic controller success can be better predicted by dynamic testing such a simulator based testing or complex work samples.

An integration of both methodologies will be the best way to manage and optimise the selection process and assessment of candidates of training

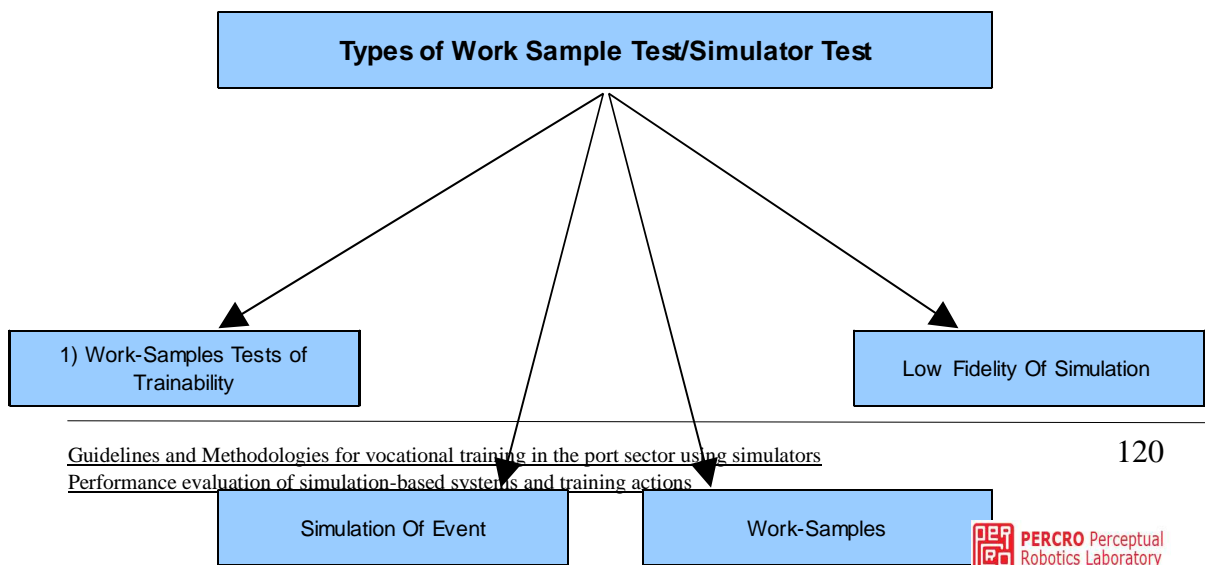
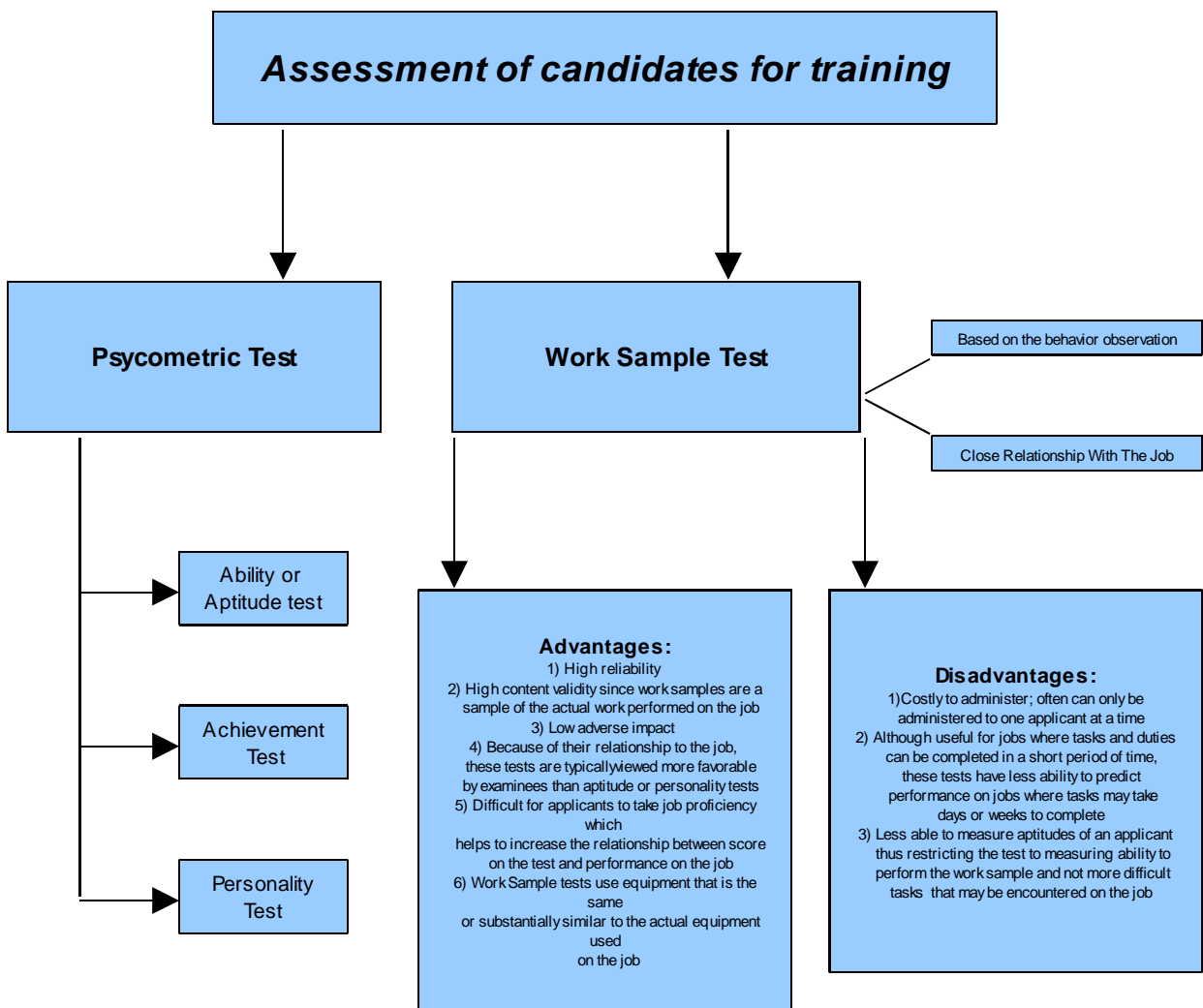
At general level to set psychometric testing, work sample testing or simulator testing in a specific work environment is necessary to consider the stages at which each is relevant.

The selection issue- in training process for port sector – can be conceptualised at least in four different stages

- Initial selection
- allocation of trades or specialisation
- screening for advanced training courses
- individualisation of training process.

The type of test used varies from fully validate psychometric test to informal instructor assessment. At general level psychometric test are found in the first stages of selection training process, work sample or simulator test are fitting in the more

advanced parts of process of assessment of candidates but they could be very useful in the first stages too.



### 3.3.2 Evaluation in Simulation Based Training. A model

The relationship between measures of training performance and the achievement of training goals is often difficult to quantify.

This continues to be an obstacle to the development of curricula for simulation based training systems.

This simple and useful methodology discusses the development of training effectiveness measures as they relate to the design of instructional, simulation-based training systems featuring automated tools for planning training.

One of the first systematic and most effective training models developed was the SAT and **this evaluation experimental model is designed with a direct connection with SAT task analysis and distinction in tasks and related subtasks.**

Our opinion is that simple but useful experimental methodology is suitable for evaluation of simulation based training sessions in port sector.

#### 3.3.2.1 *Measuring the Effectiveness of Simulation-Based training*

Measuring the Effectiveness of Simulation-Based training will depend on how well the components of his SAT model are integrated into training curricula.

According to Williams, Reynolds, Carolan, Anglin & Shrestha (1989), there are several important factors to consider when integrating simulation training into an organization's training program.

- First, the simulation training must be linked to strategic objectives of the organization.
- Second, it must also be directly related to the functions and processes of the organization.

- Third, training system development must be perceived by system users as relevant to real-world tasks.

In this way training curricula will provide information and training for accomplishing real-world and work environment tasks.

The approach presented here for conducting and measuring the effectiveness of simulation-based training generally follows the SAT process described above.

The six major components of the experimental simulation based evaluation process are:

- 1. Training task identification**
- 2. Training proficiency evaluation;**
- 3. Training task prioritization;**
- 4. Identification of simulation training support**
- 5. Simulation training execution**
- 6. Feedback**

### **Step 1**

Identification of training tasks to evaluate for simulation-based training curriculum has benefited from at least twenty years of extensive analysis in this area.

We need to subdivide major tasks into subtasks with standards for accomplishing each one. The work is identify from mission analysis task and subtasks to use in simulation based training evaluation.

### **Step 2**

The second component is the assessment of a training proficiency at performing mission related training tasks against a measurable standard.

It is important that task proficiency be evaluated in a clear manner that accurately reflects the training operator's ability to perform key and essential tasks for accomplishing specific missions.

Task evaluation may be performed by the operator or the team undergoing training or by an outside, independent evaluator.

In some cases, task proficiency standards are measurable, fixed criteria.

Performance outcomes are usually assessed as pass or fail (i.e., go or no go), this helps remove subjectivity and ambiguity that might otherwise bias training performance measurements (see Gonzalez & Ingraham 1994).

### **Step 3**

The third component, prioritization of tasks and subtasks, is a preliminary step to identifying and scheduling training support and resource. i.e. the fourth, the fifth and the sixth represent the implementation and analysis steps

Task prioritization also help training managers to select training scenarios that meet the training goals.

**The training task rankings**, reflecting the value of each training task to mission accomplishment, and training performance scores obtained during simulation training execution **are used to determine training proficiency scores.**

### **Step 4,5 and 6**

They represent the implementation and analysis steps

#### **3.3.2.2 Evaluation**

The operator receives feedback during and after action review of training performance and lessons learned.

Training evaluations provide with quantitative results in the form of an overall score that benchmarks their performance during training and training results are also used for adjusting task prioritization to reflect updated training priorities.

This marks the start point for the next iteration of the simulation-based training process and this methodology requires that tasks be identified in advance of training.

Following this, **each task is ranked (weighted), relative to the others.**

In this proposed methodology weights reflect the importance of each task to mission accomplishment. The highest level tasks, level 1, are usually described in broad, general terms, these high level tasks are the ones that must be successfully completed for the operator to achieve aim or mission success.

At each level, task decomposition leads to more basic, specific subtasks.

Working down the tree, lower level subtasks generally reflect “how” the parent task is to be accomplished, and different weights must be determined for each subtask.

As mentioned above, they represent the importance of subtasks to mission or parent task accomplishment.

The combined weights of all subtasks branching from a parent task must sum to one.

The tree is solved, branch by branch, starting at the lowest level and working up, a linear combination of weights  $W$  and scores  $S$  is computed for each branch.

These are rolled up to the next branch and added to the linear combination of weights and scores for the parent node.

### 3.3.2.3 Conclusion

The potential value of the methodology presented in this paper is potentially very interesting for the port sector: application in logistic sector guaranteed very useful results

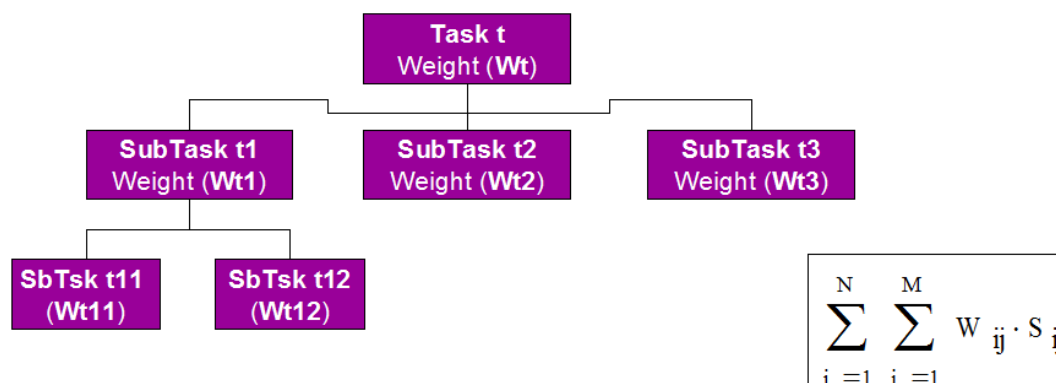
Future work in OPTIMUS project will include testing and evaluating the methodology and training effectiveness measures in simulation-based training experiments to be conducted in collaboration with port authorities partners of OPTIMUS Project.

Below we try to do an application of proposed methodology



The job mission is splitted in task and each task is ranked by a weight that reflects the importance of each task to mission accomplishment

The same approach is applied in each task splitted down to elementary subtasks.



### **3.3.3 Operate a reach steacker. A PERCRO application of the proposed methodology**

The current level of simulator sophistication permits the simulator program itself to evaluate the student's performance. The simulator can evaluate the degree to which the student met the performance parameters established for the run.

Following is an example of a PERCRO laboratory application of this proposed methodology of evaluation to a typical port worker profile: Reach Stacker operator.

Obviously the described methodology is suitable to many others portworker professional profiles for instance dock gantry crane operator.

The first step of the application of PERCRO Methodology is a clear definition of unit Aim, Task, Subtask and training objectives

#### **UNIT AIM**

Operating a reach stacker takes place within a regulatory framework that seeks to ensure safety of the operator, the reach stacker and its environment. Reach stackers are inherently dangerous; hence, their safe operation cannot be overstated. The learner will also acquire the competencies and skills to operate the components, systems and joy sticks to accomplish the task of lifting and handling loads appropriately. The aspects of safety and communication during the lifting operation are covered.

#### **UNIT Tasks:**

- Discuss and apply the regulatory framework for operating reach stackers.
- Describe the reach stacker to be operated.

- Demonstrate mechanical awareness of the selected machine.
- Inspect the selected reach stacker.
- Handle loads with a reach stacker.
- Operate the reach stacker.

### **Training Objectives:**

Learners credited with this standard will be able to:

- Discussing and applying the regulatory framework for operating reach stackers.
- Describing the reach stacker to be operated.
- Demonstrating mechanical awareness of the selected machine.
- Inspecting the selected reach stacker.
- Handling loads with a reach stacker.
- Operating the reach stacker

## **Training Unit: Operating the reach stacker.**

### **TASK 1:**

**Discuss and apply the regulatory framework for operating reach stackers.**

**RANGE of application:** Includes but is not limited to relevant sections of current legislation of the Occupational Health and Safety

- The responsibility of the employer and employees regarding health and safety are explained in terms of the legal obligations on both parties.
- The importance of the right to information is explained to ensure that health and safety issues are not compromised.
- The regulations pertaining to personal protective equipment are explained and applied to ensure that appropriate precautions are taken in the workplace.
- The regulation pertaining to stacking is explained and applied to ensure safety of self and others.
- The regulation pertaining to driven machinery are explained and applied to maintain the safety of the reach stacker environment.
- The code of practice and safety procedures of the organisation are described to ascertain whether they are in conformity with the regulatory framework for reach stackers.

**EVALUATION TOOL:** questionnaire and test

### **TASK 2**

**Describe the reach stacker to be operated.**

- The reach stackers are described to demonstrate detailed knowledge of the different types of cranes in a category.

**(RANGE of application:** types of reach stackers refers to the types within the crane categories)

- The functionality of and the context within which the reach stackers can be operated are discussed to demonstrate knowledge of the use of these machines at the appropriate level.
- The limitations, capabilities and capacities of the reach stacker crane to be operated to ensure that it is used according to manufacturer's instructions.

**EVALUATION TOOL** questionnaire and test

### **TASK 3**

**Demonstrate mechanical awareness of the machine.**

- The major components of the reach stacker are identified and described in terms of their functions in the operation of the machine
- The systems of the reach stacker are described in terms of their features, functions and inter-relatedness.
- The instrumentation of the reach stacker is explained in terms of their functions and what the operator must do in case of a deviation

**(RANGE of application:** Instrumentation includes gauges, indicators, warning devices.)

- The operation of the joy sticks, controls and safety devices is explained and monitored in order to maintain safety during operations.
- The attachment/s of the reach stacker is/are used as per manufacturer's instruction and standard operating procedure

**(RANGE of application:** The attachment/s of the reach stacker include: hooks, chains, spreader etc.)

## EVALUATION TOOL questionnaire and test

### TASK 4

#### Inspect the reach stacker

- Pre-start checks are performed to ensure that the reach stacker is safe for operation.
- Start up procedure is performed according to manufacture's instructions.
- Shut-down procedure is performed to ensure the reach stacker is serviceable for the next operator/shift.
- Reach stacker is maintained according to manufacturer's instruction and standard operation procedure.
- Problems are recorded and reported according to standard operating procedure.

(NOTES Apply the recognised methods for inspecting and recording the operational fitness of all components of the crane (e.g. structural components, hydraulic systems, cab, fastenings, ropes/chains etc).

## EVALUATION TOOL questionnaire, test and/or simulator test

### TASK 5

#### Handle loads with a reach stacker.

**RANGE** Handle includes identifying, lifting, stacking, de-stacking and re-handling of containers.

- The physical properties of a container are identified and described according to criteria

(**RANGE** Criteria include but are not limited to density, dimensions, centre of gravity, stability of a suspended load)

- The appropriate attachment/s for the load type, if applicable, are selected and used as per manufacturer's instructions
- Specific loads are handled according to standard operating procedure
- The operational capability of lifting equipment is assessed to ensure safety.

(**RANGE** Includes but is not limited to correct SWL of slings)

**EVALUATION** by embedded test on simulator

## **TASK 6**

### **Operate the reach stacker**

- Principles of operations/leverage are explained and applied to ensure safe and effective lifting operation
- Load capacity of the reach stacker and its load are determined as per standard operating procedure
- Safe operating procedures are complied with to ensure safety of people, machines and the environment

(**RANGE** Procedures include emergency procedures, procedures to deal with hazardous materials when being handled by the operator)

- The machine is operated according to its load capacity (SWL).
- Communication skills are used during operation of a reach stacker

## **NOTES**

React to recognized hand signals (and other methods of communication) and to direct the reach stacker movements accordingly, whilst considering and/or adjusting to circumstances in the interests of safety.

**RANGE** of application:

Communication skills include bat, hand signals and radio communications

**EVALUATION** by embedded test on simulator

In the second step we try to identify, for the most important training objectives defined in the reach stacker training programme, the objectives that are suitable to be trained and of course evaluated with a simulation platform, with a specific simulation scenario and specific scale of evaluation.

From the training programme for Reach Stacker operator, training objectives that are suitable for simulation based training and evaluation are:

Training objective 5. **Handle loads with a reach stacker.**

Training objective 6. **Operate the reach stacker**

Now we try to develop a specific exercise scenario for training objective 5 with specific learning contents and duration, for instance:

**Handle loads with a reach stacker**

<b>EXERCISE SCENARIO</b>	
<b>Handle loads with a Reach Stacker</b>	
<b>Test</b>	<b>Duration</b>
Free trials.	20 min

<b>EXERCISE SCENARIO</b> <b>Handle loads with a Reach Stacker</b>	
<b>Test</b>	<b>Duration</b>
<p>Execution of manoeuvres.</p> <p>Each manoeuvre is to pick up the container from an area and the storage in another one. There is a series of possible combination that the instructor can choose:</p> <p>The pick up of the container could be:</p> <p>pick-up the container from the ground  pick-up the container from a stack of containers (low level)  pick-up the container from a stack of containers (high level)  pick-up the container from the truck</p> <p>The storage of the container could be:</p> <p>Storage of the container on the ground  Storage of the container on a stack of containers (low level)  Storage of the container on a stack of containers (high level)  Storage of the container on a truck</p>	60 min

The third step of PERCRO methodology is to develop a specific scale for the evaluation of most important mistakes in container handling.

### **Level of Mistakes**

During the simulator session, some mistakes are reported and classified by a scale:

**Low level mistakes: 1** – the manoeuvre has been effectuated with imperfection that may cause the loosing of the load

**Medium level mistakes: 2** – the manoeuvre could provoke an accident with damages for the operator and people in the nearby.

**High level mistakes: 3** – the manoeuvre could provoke an accident with injury for the operator and people in the nearby.

The most important types of mistakes are underlined below with different level of experimental evaluation weight.

<b>Main Types of mistakes</b>	
<b>Mistake description</b>	<b>level</b>
Too high speed during container handling	3
Failed compliance to vertical and horizontal signals	3
Driving without container with high attachments	2
Failed use of acoustic signal system where prescribed	2
Failed perception of container dimensions	1
Uncertainty in pick up or storage of container	1
Uncertainty in handling container	1
Mistakes during container handling	2
Failed use of attachments	2
Advancing with load that occlude front view	3
Cover reverse way without control	3
Handling container over Load capacity of the reach stacker	3
Storage of container over the capacity of container stack	3

**Score is the total of mistakes made in the simulation based session**

The same methodology could be applied for another port worker profile: for instance gantry crane operator.

### 3

## 4 CONCLUSIONS

These guidelines and methodologies are an experimental effort to define a specific and effective methodology to design and evaluate simulation based training for vocational training in the port sector

The Systems Approach to Training is adapted for the main issue of development a methodology to analyze organizational and individual training needs, to design a training program with use of simulation devices, and finally to evaluate training program with application of structured and proved methods.

Our methodology, a synthesis and adaptation to simulation based training for the port sector of the most significant and used methodologies of training development and evaluation, is able to determine each steps needed to design and implement a simulator based training program according to aims of the OPTIMUS Project

In the training evaluation section, we have identified also different level of evaluation tools: from simple to complex training evaluation models, defining specific objectives and specific operative tools. We paid particular attention to define an experimental but operative methodology to evaluate simulation based training program and proposed a direct PERCRO application to assessment reach Stacker operators trained with use of simulation devices.

These methodologies needs a strong experimental field to understand the real application in the port sector of this approach on simulation based training evaluation and assessment.

## 5 APPENDIX

## **A.1 A GUIDELINE TO SCENARIO DEVELOPMENT AND EVALUATION IN SIMULATION BASED TRAINING**

### **A step by step guide**

The methodology development process was driven by a review of current literatures on the design of simulation scenarios and measurement tools as well as the development of selection systems and test items and practical experience implementing the methodology in developing the prototype simulation.

This section details the eight-step methodology we developed while creating an initial assessment scenario.

### **Step 1. Define clearly what to be measured and linking to training needs**

Any effective measurement system begins with a clear definition of what is to be measured. In this case, of using performance in simulations as an indicator of performance, the ultimate goal is to obtain a measure of proficiency in the Knowledge, Skills and attitudes underlying effective performance within a domain.

The tasks to be performed in this step include:

- Perform a document review of task analysis, training materials, technical manuals, and standard operating procedures. .
- Conduct structured interviews with SMEs.
- Compile a list of competencies and associated performance contexts.

## **Step 2. Measure of success at start**

To ensure that the critical aspects of the domain are represented in the test a strategy for developing scenarios, events and critical responses must be developed that meets two high level goals.

First, each scenario including the events and targeted responses must be clearly linked to the targeted competencies. This ensures that aspects of performance not related to the domain competencies do not become a part of performance measurement and subsequently the selection decision.

Second, systematically linking scenario development to the targeted competencies affords the ability to track what competencies have and have not been sampled by the simulation scenario. This ensures the opportunity to sample the entire domain and to avoid under representing the targeted competencies in the performance that the simulation captures.

When test length is an important concern, sampling the competencies that are most discriminative is a logical strategy. Additionally, methods of sampling strategies for competencies can focus on time, criticality, and level . That is, competencies can be chosen based on the relative amount of time individuals spend on the job using the specific competency, the degree to which the competency distinguishes between successful or unsuccessful staff, or the degree of the competency needed to perform successfully on the job.

An idealized approach would involve the following steps given that SME ratings of frequency, criticality, difficulty, and level of activity and knowledge focused competencies are not available.

### **Steps 3. Design and implement training programme**

The process of developing simulation scenarios is central to using simulations for selection purposes. Cognitive and behavioural task analysis techniques can be leveraged to sample the range of tasks required and situations encountered for a specific job. The Critical Decision Method and other event-based knowledge elicitation techniques can be used to generate critical events and targeted responses that can be linked to the competencies of the domain.

For procedural skills, the fundamental outlines of simulation scenarios can often be generated from existing technical and training references.

Once an outline of the simulation has been created, the general process involves progressively contextualizing the abstract competencies, using SME guidance to focus on key competencies, using supporting documentation to generate the overall structure of a scenario, and using SME interviews to provide details about each component of the procedural task.

The end goal of this process is to create a simulation scenario and populate it with 'items' (i.e., the scenario events) to which the user is expected to respond. Scenario events should be realistic, of the appropriate level of difficulty, provide multiple opportunities to display targeted competencies, and sequential dependencies should be avoided in the measurement associated with events (Fowlkes & Burke, 2005 Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC))

### **Step 4. Decide evaluation methods and encode in a measurement tool**

The nature of responses to simulation events is critical in determining the correct scaling technique.

For this reason, the scenarios need to be created before determining how to assess the scenario responses. There are multiple ways to capture performance in simulations. Event-based measurement can result in dichotomous scoring (e.g., did the individual exhibit the targeted behaviour?) or through other types of ratings (e.g., Likert type scaling in Behavioural Observation and Behaviourally Anchored Rating scales). Deciding on the best scaling technique involves considering the characteristics of the performance being measured as well as the goals of the measurement system (in this case, selection).

#### **Step 5. Have scenarios reviewed by subject matter experts (SMEs)**

Just as it is recommended for SMEs to review test items during development of traditional selection tools, SMEs can provide valuable insight into how representative the scenarios and measurement tools are of actual performance. This relatively simple step ensures the ‘face validity’ of the scenarios, a facet that can greatly affect how an individual perceives and performs within the simulation. It also serves as a check on the appropriateness of the sampling strategy developed and implemented.

#### **Step 6. Administer the simulation and measurement tools to a developmental sample**

The simulation should be run with a sample from the intended population of use for validation purposes. Additionally, measurement of this sample’s subsequent performance on the job should be collected.

This data will allow for validation and optimization of the simulation test.

#### **Step 7. Evaluate the scenarios and measurement tools**

Using the data from the developmental sample, the characteristics of the simulations scenarios and measurement tools can be evaluated.

Specifically, the item response characteristics for each scenario event can be determined. This will enable the process of choosing and refine the simulation test to meet the specific requirements of the selection task.

The primary means by which this is accomplished is through correlating simulation scores with other measures of competency.

However, additional work is required to establish the validity of multiple sets of scenarios as equivalent tests of competency. This problem is equivalent to developing parallel forms of tests in traditional test or selection tool development.

There are several options available to establish the validity of using parallel or alternate forms of tests

The first strategy involves administering both sets of scenarios to the same group of individuals.

Ideally this group of individuals would represent a continuum of competency so that there is variation in the scenario scores between participants. The degree to which the individual's scores on the different scenarios are correlated is evidence of the validity of using the scenarios as equivalent tests.

Second, scenario scores from each set can be correlated with other measures of competency .

This can be done in conjunction with the first strategy or in a between subjects fashion with each set of scenarios being administered to separate groups. The degree to which the two sets of scenarios show similar patterns of relationships with these other indicators of competency can be taken as evidence of the validity of using the two sets of scenarios as parallel test forms.

Third, the scenarios can be reviewed in terms of the degree to which they reflect or sample the same competencies.

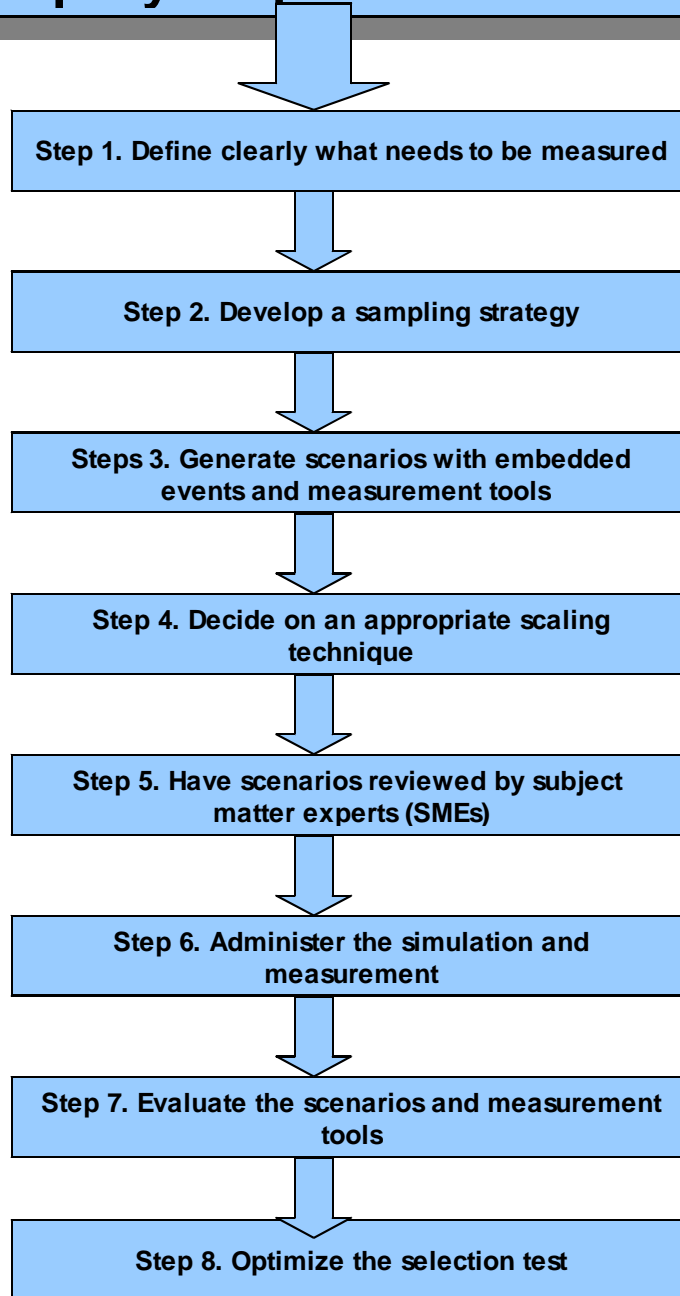
This review would involve subject matter expert ratings of the criticality, frequency, and difficulty of the activity competencies, domains of knowledge, and contexts of performance reflected in each set of scenarios. The degree to which these ratings match is evidence of the validity of using the two sets as parallel forms. All of these strategies can be employed to build the strongest case possible for using different sets of scenarios as equivalent.

### **Step 8. Optimize the selection test**

The simulation-based test can be optimized using information from the evaluation of the data gained from the developmental sample. This information can be used to maximize the predictive power of the test.

As in traditional scale development, test length and predictive power of the test are often at odds with the practical considerations demanding the shortest tests possible. This is the case with simulations as well; using item response theory and psychometric principles of test design, the shortest tests (simulations) can be designed with the highest level of prediction and therefore the most utility in selection.

# A Step By Step Guide



## **A.2 TRAINING THE TRAINERS. SIMULATION BASED TRAINING INSTRUCTORS**

The role and qualification of simulator instructors evokes considerable discussion and debate. Some people in the simulator based training field believe the instructor is the most important training element;

The view taken in this part of report is that although all design components are important to an effective course of instruction, the relative quality of simulator-based training depends more **on the instructor's capabilities** than those of the simulator or the role of the trainee.

The instructor is of primary importance because it is the instructor's role to ensure that *all* of the instructional objectives are met.

In developing a training program, the application of SAT System requires consideration of the following factors for instructors:

- curricula requirements;
- instructor recruitment or selection to meet curricula requirements;
- instructor professional credentials and their maintenance;
- instructional capabilities, including their development and maintenance; and
- instructor capability to operate simulator resources and integrate them into effective learning programs.

As a practical matter, the instructor's subject-matter expertise is essential to instructional design.

The instructor's *tasks*, however, are multifaceted.

Many of the instructor's tasks are in addition to and lie outside of the professional port expertise.

As an instructional tool, simulation has evolved to a level of technical and instructional sophistication that often requires multidisciplinary expertise and technical support.

In such cases, the instructor needs to be capable of working as a member or leader of an instruction team.

### **Instructional Tasks**

- **Development of a thorough professional knowledge of the subject matter**
- **Maintenance of up-to-date knowledge about relevant developments in port operations**
- **Development of a thorough knowledge of the functional operation of the simulator**
- **Development and implementation of training courses, including objectives and, if appropriate, integration of these courses into the total training program.**
- **Development of simulation scenarios that best support instructional objectives.**
- **Communication with industry and professionals regarding requirements and details of training courses (i.e., training needs).**
- **Preparation of all necessary course material and equipment.**
- **Validation of databases and scenarios.**
- **Preparation of incoming courses and coordination of schedules and training strategy with other members**
- **Conduct of courses in a professional manner, using proven and agreed-on teaching methods and skills.**

- **Supervision or conduct of debriefings.**
- **Preparation and development of trainee evaluation process.**

### **Instructor role in training using simulation**

Researcher has the conviction that apart from the high-tech simulators in use and under design phase, it is ultimately the instructor who can make the real difference in achieving the competency standards as desired in the Convention.

Instructor is actually responsible to connect up the simulator experience with real operations through his visualization and must not let the trainees get into a discourse or fall into a game mood.

People feel difficulty to overcome the simulation artificiality.

So, one of the major disadvantages of the simulator based training is the artificiality of the equipment involved. It's the psychological environment created by the instructor which can reduce the negative effects of the in-built artificiality of the simulator based training.

Reliability of simulator based training means that instructor was able to impart all the performance standards to the trainees as he planned in the exercise or were part of the training objectives.

Uniformity of the simulator based training means that when same simulator exercise is run for multiple trainees at different times, it has same training value with respect to basic learning out comes.

### **Monitoring by the Instructor**

It is very important that simulator has the features of a comprehensive monitoring system in order to observe the trainees properly form the Instructor Control Station.

Instructor should have multiple ears and eyes and easy control over whole of the working area so that he can perform in a peaceful manner. Finally, recording of whole exercise including audio / video should be available for re-running in the debriefing of the exercise and analysis.

### **Briefing before Session**

A briefing has to be conducted before commencement of the exercise by the instructor for the trainees. It is advisable to have briefing in the simulator room itself when explaining various parts and equipment. When more than one instructor / staff is involved, all instructors should be present during the briefing session, thereby giving chance to the trainees to raise questions if any and also to recognise and develop mutual relationship with instructors / staff that will be conducive in achieving the exercise objectives.

Briefing should include all the set conditions of the exercise and exercise objectives; number of trainees involved, trainee leader if any or the team composition, instructors involved and their respective tasks, time duration, break time and duration in the exercise.

### **Exercise Conditions**

Before commencing the active training session on simulator, it is recommended that exercise design should include all the conditions to be set on simulator at start time.

This will increase and ensure the validity of training session.

Conditions include listing of all the equipment that will be used during the exercise and also the equipment which is not fitted or not available during the session.

Conditions also include;

1. Equipment not fitted / available.

2. Equipment fitted / available.
3. Equipment made defective as per settings.
4. Equipment having any error.
5. Initial simulator settings, scenarios.
6. Weather conditions.
7. Traffic conditions.
8. Weather and Visibility.
9. Manpower available.

Standardising these conditions for subsequent exercises will give reliability of the training being conducted for multiple classes at different times.

### **Feedback on Simulators**

Realization of this potential, however, depends upon the ability of simulator training program to take into account the special cognitive needs of the trainees and ability of the instructor to properly provide the feedback to the trainees.

**Feedback** to the trainee on simulator regarding standard of his performance is very important for maintaining interest, keeping morale and improving performance of the trainee

With regards to effectiveness of the feedback provided to the trainees, two factors are important to be considered while providing feedback:

**Timing** of the feedback is very important.

Some errors can change the subsequent run of the exercise and need to be corrected immediately. While, there are errors which take time to produce results and instructor will be more prudent if he waits and delays the feedback. Delayed feedback also helps the trainees with time to think and analyse their actions and consequences.

**Redundancy** is another factor influencing the performance feedback's effectiveness. Studies indicate that repetition of same feedback may reduce interest and motivation of the trainees.

### **Relationship between Instructor and Trainee**

Skinner (1968) asserted that importance of instructor is clear in the frequency with which he is blamed when new policies or systems of administration or method of teaching fails to improve the education and training.

Also, any weakness on part of the instructor with respect to knowledge, confidence and commitment will be noted by the trainees and will adversely affect the learning outcome.

To find out their observations regarding the qualities and capabilities of the instructors they came across during simulator training, question was posed to the operators as under; What was the major observation you had during simulator training about the instructor/s with respect to his/their handling of the simulator exercise?

1. His/their knowledge of the subject was not up to the desired level.
2. He/they were not confident on the simulator equipment fitted.
3. He/they were not committed to the training requirements.

R: They put up their observations indicating that either the knowledge of the instructor was below the required level or they did not feel confident on the simulator equipment.

### **Development of Attitude:**

Purpose of the education and training is to develop capabilities in the trainees. These capabilities vary in nature but are interdependent and are present in different proportion in all forms of education and training activities

- Intellectual Skills,
- Verbal Information,
- Cognitive Strategies,
- Motor Skills, and
- Attitudes.

Development of attitudes and shaping the behaviour is one of the important elements of any education and training activity and largely depends upon the quality and characteristics of the instructor.

When we discuss an instructor, his role is not limited to knowing the subject matter, coming to the class room, delivering a lecture for a period of 40 minutes or so and all is over. An instructor has to take the responsibility of various stages of the training process which include but not limited to the following;

- Knowledge of the subject matter,
- Course design,
- Selecting appropriate learning activities,
- Preparation and use of instructional media,
- Assessment and evaluation of the trainees
- Course evaluation and amendments.

## **A.3 TDT1097 OPERATE A FORKLIFT . THE COMPLETE STANDARDIZED UNIT**

### **6**

## **TDT1097 Operate a forklift (ANTA)**

### **Performance Criteria**

#### **Check forklift condition**

1. Condition of forklift is checked for compliance with OHS and workplace requirements for warning devices, manufacturer's specifications and the nature of the load shifting task
2. Attachments are checked to ensure appropriate adjustment and operation
3. Mirrors and seats are adjusted for safe operation by the driver
4. Log books are checked and appropriate workplace documentation is completed in accordance with workplace requirements

#### **Drive the forklift**

1. Forklift is started, steered, manoeuvred, positioned and stopped in accordance with regulations and manufacturer's instructions
2. Engine power is managed to ensure efficiency and performance and to minimise engine and gear damage
3. Operational hazards are identified and/or anticipated and avoided or controlled through defensive driving and appropriate hazard control techniques

4. Forklift is driven in reverse, maintaining visibility and achieving accurate positioning
5. The forklift is parked, shut down and secured in accordance with manufacturer's specifications, regulations and workplace procedures

### **Operate a forklift to handle loads**

1. The lifting task to be undertaken is appropriately planned and the correct lifting truck and attachments are selected
2. The load is lifted, carried, lowered and set down in accordance with OHS legislation, manufacturer's specifications and company procedures

### **Monitor site conditions**

1. When selecting the most efficient route, hazards and traffic flow are identified and appropriate adjustments are made
2. Site conditions are assessed to enable safe operations and to ensure no injury to people or damage to property, equipment, loads or facilities occurs

### **Monitor and maintain forklift performance**

1. Performance and efficiency of vehicle operation is monitored during use
2. Defective/irregular performance and malfunctions reported to relevant personnel
3. Forklift records are maintained/updated in accordance with workplace procedures and legislative requirements

## Evidence Guide

Critical aspects of evidence to be considered

- Assessment must confirm appropriate knowledge and skills to:
  - operate a forklift safely in a workplace environment
  - handle loads and drive defensively
  - manage forklift controls, read instruments and adjust engine power to site requirements
  - locate, interpret and apply relevant information
  - carry out pre-operational checks on a forklift
  - work effectively with colleagues
  - convey information in written and oral form
  - maintain workplace records
  - use workplace colloquial and technical language and communication technologies in the workplace context
  - meet relevant regulatory requirements

### Interdependent assessment of units

- This unit of competency may be assessed in conjunction with other units that are part of a worker's job function

### Required knowledge and skills

- Knowledge of relevant duty of care requirements pertaining to the operation of a forklift
- Relevant OHS and environmental procedures and regulations
- Forklift controls, instruments and indicators and their use
- Forklift handling procedures
- Procedures to be followed in the event of an operational emergency
- Engine power management and safe operating strategies
- Efficient driving techniques
- Pre-operational checks carried out on forklift and related action
- Site layout and obstacles
- Operating hazards and related defensive driving and hazard control techniques
- Principles of stress management when driving a forklift
- Workplace operating procedures
- Ability to identify points of balance and safe lifting positions on a range of loads when operating a forklift
- Ability to read instructions, procedures and signage relevant to the operation of a forklift
- Ability to monitor and anticipate operational hazards and take appropriate action

## **Resource implications**

- Access is required to opportunities to:
  - participate in a range of exercises, case studies and other real or simulated practical and knowledge assessments that demonstrate the skills and knowledge to operate a forklift to carry out a range of load shifting operations in a workplace, and/or
  - operate a forklift to shift loads in an appropriate range of operational situations

### **Consistency in performance**

- Applies underpinning knowledge and skills when:
  - operating a forklift safely in workplace environment
  - handling loads and driving defensively
  - managing forklift controls, reading instruments and adjusting engine power to site requirements
  - locating, interpreting and applying relevant information
  - carrying out pre-operational checks
  - working effectively with colleagues
  - conveying information in relevant form
  - maintaining workplace records
- Shows evidence of application of relevant workplace procedures including:
  - relevant State/Territory regulations and licence requirements pertaining to forklift operation
  - OHS policies and procedures

- identification of operational hazards and the use of appropriate defensive driving and hazard control techniques
- workplace procedures and work instructions (including security and housekeeping procedures)
- forklift manufacturer's guidelines and instructions
- environmental protection procedures when operating a forklift and carrying out pre-operational checks
- Action is taken promptly to report and/or rectify accidents, incidents and any identified faults or malfunctions in accordance with manufacturer's instructions, regulatory requirements and workplace procedures
- Performance is demonstrated consistently over a period of time and in a suitable range of contexts
- Work is completed systematically with required attention to detail and without injury to self or others or damage to goods or equipment

### **Context for assessment**

- Assessment of competence must comply with the assessment requirements of the relevant State/Territory forklift licensing authority
- Assessment of this unit must be undertaken by a Registered Training Organisation:
  - As a minimum, assessment of knowledge must be conducted through appropriate oral and/or written questioning
  - Appropriate practical assessment must occur:
    - at the Registered Training Organisation, and/or

- in an appropriate work situation

## **Range Statements**

### General context

- Operation of a forklift must be carried out in compliance with the licence requirements and regulations of the relevant State/Territory authority.
- Operation of a forklift is performed under some supervision, generally within a team environment.
- Operation of a forklift involves the application of routine equipment operation principles and procedures to maintain the safety and operation of a forklift in a variety of operational contexts.

### **Worksite environment**

- Types of forklift may include counterbalance trucks, reach trucks and pallet trucks.
- Operations may be carried out in typical forklift operational situations, including:
  - operations conducted at day or night
  - typical weather conditions
  - on the open road
  - on a private road or worksite
  - while at a workplace
- Customers may be internal or external

- Workplaces may comprise large, medium or small worksites
- Work may be conducted in:
  - restricted spaces
  - exposed conditions
  - controlled or open environments
- Loads to be shifted may require special precautions
- Loads to be shifted may be:
  - irregularly shaped
  - packaged or unpackaged
  - labelled or unlabelled
  - palletted or unpalletted
- Hazards in the work area may include exposure to:
  - chemicals
  - dangerous or hazardous substances
  - movements of equipment, goods and materials
- Personnel in the work area may include:
  - workplace personnel
  - site visitors
  - contractors
  - official representatives
- Forklift handling procedures may include:
  - starting a forklift

- steering and manoeuvring a forklift
- accelerating and braking
- positioning and stopping a forklift
- reversing a forklift
- operating forklift controls, instruments and indicators
- using defensive driving techniques
- managing engine performance
- Pre-operational checks may include:
  - visual check of forklift
  - checking and topping up of fluid levels
  - checks of tyres
  - checks of operation of forklift lights and indicators
  - checks of brakes
- Hazards may include (examples only):
  - wet and iced operating surfaces
  - oil on operating surface
  - faulty brakes
  - workplace obstacles and other operational equipment and vehicles
  - damaged loads and palletts
  - other personnel in work area
- Depending on the type of organisation concerned and the local terminology used, workplace procedures may include:

- company procedures
- enterprise procedures
- organisational procedures
- established procedures
- Personal protection equipment may include:
  - gloves
  - safety headwear and footwear
  - safety glasses
  - two-way radios
  - high visibility clothing

### **Sources of information/ documents**

- Information/documents may include:
  - goods identification numbers and codes, including IMDG markings and HAZCHEM signs
  - manifests, bar codes, picking slips, merchandise transfers, stock requisitions, goods and container identification
  - Australian Standard 2359 - Industrial Truck Code
  - manufacturer's specifications for forklift and associated equipment
  - operations and service record book or log
  - workplace procedures and policies for the operation of forklifts
  - supplier and/or client instructions

- ADG Code and material safety data sheets
- regulatory requirements concerning the use of forklifts
- award, enterprise bargaining agreement, other industrial arrangements
- standards and certification requirements
- quality assurance procedures
- emergency procedures

### **Applicable regulations and legislation**

- Applicable procedures and codes may include:
  - relevant State/Territory regulations pertaining to the operation of forklifts
  - relevant codes and standards, including Australian Standard 2359 - Industrial Truck Code
  - relevant State/Territory OHS legislation
  - relevant State/Territory fatigue management regulations
  - relevant State/Territory environmental protection legislation

### **Key Competencies**

The seven Key Competencies represent generic skills considered necessary for effective participation by an individual in the workplace.

Performance Level 1 - at this level, you are required to undertake tasks effectively

Performance Level 2 - at this level, you are required to manage tasks

Performance Level 3 - at this level, you are required to use concepts for evaluating and reshaping tasks

The following Key Competency levels have been considered within the structure of this unit's Performance Criteria.

Code	Level	Example
How can information be collected, analysed and organised?	1	
How are ideas and information communicated within this competency?	1	
How are activities planned and organised?	2	
How are problem solving skills applied?	1	
How are mathematical ideas and techniques used?	2	
How is use of technology applied?	2	
How is team work used within this competency?	2	

## **GLOSSARY**

**Ability:**

physical or mental competence at performing a category of tasks due to training.

**Assessment:**

the process of quantifying or qualifying the performance of individual group or device

**Criterion level:**

the required level of knowledge and skills at the end of training.

**Decay of skill:**

the decrement in skill in the absence of training and experience relative to the level of skill at the end of training.

**Entry level:**

the level of knowledge and skills at start of training

**Feedback:**

provision of information concerning performance to trainee

**Full Mission simulator:**

top level training device that provides all the required cues and facilities necessary for training complete mission of a specific system.

**Function:**

a broad category of activities performed by a system

**Instruction:**

the provision of information extrinsic to the training task to enhance learning in trainees

**Instructional strategy:**

plan/method of the instructor to achieve an instructional objective.

**Instructor:**

an individual engaged assigned to delivering instruction

**Job:**

the combination of all human performance required for operation and maintenance of one personnel position in a system.

**Knowledge:**

information stored in human memory

**Learning:**

a relatively permanent change of human performance as result of training or experience

**Learning objective:**

the criterion for the result of learning

**Learning skills**

the acquisition of learning to learn with training

**Learning strategy**

a plan/method of the learner to achieve a learning objective

**Mission**

the designated goal oriented activity that a system or a team is intended to accomplish

**Mission analysis**

a process to determine the operational capabilities that are required to carry out assigned mission. The aim of mission analysis is to identify those functions required for the successful performance at general level.

**Motor skill**

the ability to move parts of the body in a coordinated fashion toward the performance of some task.

**On the job training**

training using the task or job that the trainee will be expected to perform when training is completed

**Operator**

a human being assigned to executing a particular set of tasks

**Perception**

the process of becoming aware of and interpreting external objects events or relationship based on experience following the receipt of information

### **Perceptual motor task**

any activity involving movement to non verbal stimulus.

### **Performance measure**

any objective or subjective instrument developed to evaluate personnel effectiveness

### **Retention**

the degree to which performance is maintained in the absence of training and experience relative to the performance at the end of training.

### **Scenario**

script describing a possible sequence of events and circumstances

### **Simulation**

the process of assuming the appearance and or behaviour of a real system

### **Simulator**

a device that simulates certain aspects of a real system or its environment for the purpose of training

### **Skill**

competence – level of proficiency – at performing a task due to learning; an organised and coordinated pattern of mental and physical activity developed gradually in the course of training or another experience

**Skill analysis**

detailed and systematic study of the skills needed to perform a particular task which can lead to formulation of training programme

**Subtask**

a task that is subordinate to a task at a higher hierarchical level

**Target group**

the population of applicants for training

**Task**

a goal directed composite of related activities of an operator as an output in response to a specified output

**Task Analysis**

a systematic examination on a task resulting in time oriented description of task performed by an operator showing sequential and simultaneous activities

**Test**

a procedure to determine quantity or performance measure on one or more dimensions for an individual or a system

**Trainability**

personal characteristic predictive of the ease and speed with which the individual will complete a particular training programme

**Trainee**

an individual engaged to training

**Training**

any activity of a trainee intended to enhance learning

**Training analysis**

the decomposition of a set of tasks in terms of training objectives by means of an analysis of prerequisite knowledge and skills

**Training Objective**

the criterion of the result of training; describes in behavioural terms what a trainee is expected to be able to do after training, under what conditions at what level of competence.

**Transfer**

the change in performance of a task as a result of previous learning

**Virtual environment**

computer generated three dimensional environmental simulation in which the user is able to sense and interact with that environment via a set of computer input devices.

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