EPSS FOR CARGO HOLD HUMIDITY CONTROL

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ABSTRACT

Carrying forest products like paper rolls and wood pulp requires special care. Such cargo is very sensitive to moisture. It has to be transported in a controlled, low-humidity environment to prevent damage from moisture condensation. Dehumidifiers are fitted onboard vessels to control humidity in the cargo-holds. It is the responsibility of the crew onboard the ship to control the humidity in the cargo-holds. Failure to do so may result in claims for cargo damage.

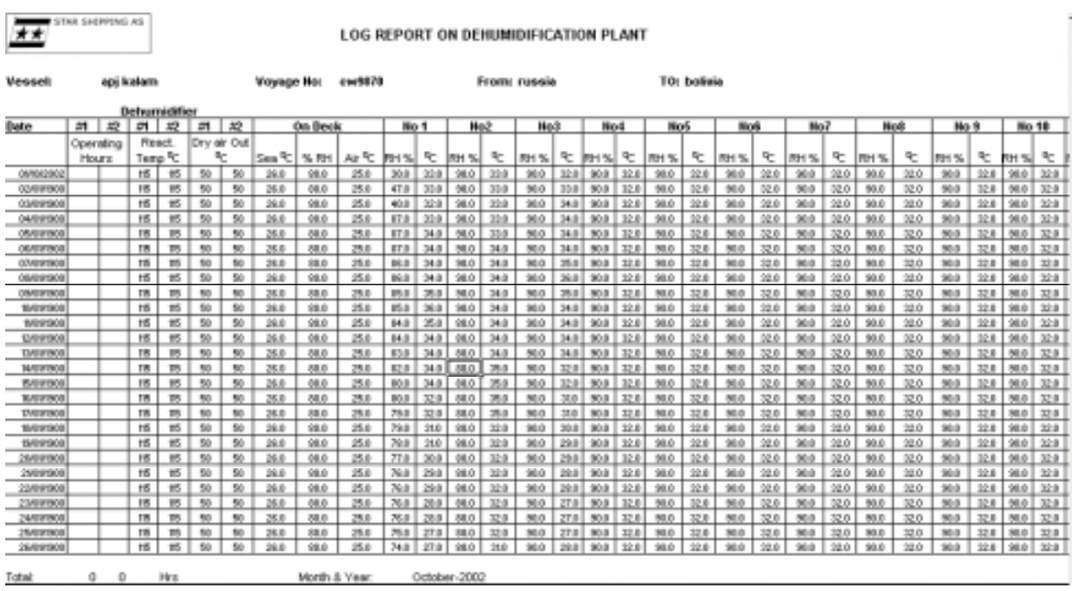
The challenge for ship owners, operators, machinery manufacturers and training institutes is to equip the ship's crew with the basic engineering skills for the correct operation and maintenance of dehumidification equipment. Even if the ship's crew has received prior training and briefing in these tasks in a shore establishment, they may have difficulty recalling the knowledge at the time of carrying out the tasks. Although they would have access to traditional hardcopy machinery manuals, these contain a large amount of text and drawings making them difficult to plough through to find the necessary information.

This paper describes a technology intervention through the use of computers to provide ship staff with consistent, one to one, just-in-time coaching using an Electronic Performance Support System (EPSS). This solution provides performance support in controlling the humidity in cargo holds. Singapore Maritime Academy has developed and delivered such an EPSS to a Singapore registered shipping company.

PROBLEM DEFINITION

Forest Product Carriers transport wood pulp, paper, steel pipes, steel slabs, glass and cotton around the world, sailing through different climatic zones. "Moisture damage" is the source of a significant number of cargo claims on such ships. Claimants typically allege that failure by the ship to ventilate correctly resulted in the development of condensation, causing the cargo to deteriorate.

However, it is also important to recognize that some commodities may have inherent moisture levels, which exceed acceptable limits, at the time of loading. The ship staff may not be aware of such details, and prudent ventilation measures may not be sufficient to prevent the deterioration of the cargo during passage. Nevertheless, claimants may still maintain that the ship was at fault. To defend against cargo deterioration claims, vessels maintain logs showing that customary ventilation routines were followed. Should the necessary evidence be missing or incomplete, it is often difficult for the insurance company to disprove such claims.



STAR SHIPPING AS

LOG REPORT ON DEHUMIDIFICATION PLANT

Vessel: apj kalam Voyage No: ew9879 From: russia TO: bolivia

Date	Dehumidifier						On Deck			No 1		No2		No3		No4		No5		No6		No7		No8		No 9		No 10	
	Operating Hours:		React. Temp °C		Dry air °C	Out °C	Sea °C	% RH	Air °C	RH %	°C	RH %	°C	RH %	°C	RH %	°C	RH %	°C	RH %	°C	RH %	°C	RH %	°C	RH %	°C	RH %	°C
01/10/2002			115	85	50	50	26.0	98.0	25.0	30.0	33.0	98.0	33.0	98.0	32.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
02/10/1900			115	85	50	50	26.0	98.0	25.0	47.0	33.0	98.0	33.0	98.0	33.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
03/10/1900			115	85	50	50	26.0	98.0	25.0	40.0	32.0	98.0	33.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
04/10/1900			115	85	50	50	26.0	98.0	25.0	87.0	33.0	98.0	33.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
05/10/1900			115	85	50	50	26.0	98.0	25.0	87.0	34.0	98.0	33.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
06/10/1900			115	85	50	50	26.0	98.0	25.0	87.0	34.0	98.0	34.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
07/10/1900			115	85	50	50	26.0	98.0	25.0	86.0	34.0	98.0	34.0	98.0	35.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
08/10/1900			115	85	50	50	26.0	98.0	25.0	86.0	34.0	98.0	34.0	98.0	36.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
09/10/1900			115	85	50	50	26.0	98.0	25.0	85.0	35.0	98.0	34.0	98.0	35.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
10/10/1900			115	85	50	50	26.0	98.0	25.0	85.0	36.0	98.0	34.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
11/10/1900			115	85	50	50	26.0	98.0	25.0	84.0	35.0	98.0	34.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
12/10/1900			115	85	50	50	26.0	98.0	25.0	84.0	34.0	98.0	34.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
13/10/1900			115	85	50	50	26.0	98.0	25.0	83.0	34.0	98.0	34.0	98.0	34.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
14/10/1900			115	85	50	50	26.0	98.0	25.0	82.0	34.0	98.0	35.0	98.0	32.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
15/10/1900			115	85	50	50	26.0	98.0	25.0	80.0	34.0	98.0	35.0	98.0	32.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
16/10/1900			115	85	50	50	26.0	98.0	25.0	80.0	32.0	98.0	35.0	98.0	33.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
17/10/1900			115	85	50	50	26.0	98.0	25.0	79.0	32.0	98.0	35.0	98.0	33.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
18/10/1900			115	85	50	50	26.0	98.0	25.0	79.0	31.0	98.0	32.0	98.0	30.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
19/10/1900			115	85	50	50	26.0	98.0	25.0	78.0	31.0	98.0	32.0	98.0	29.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
20/10/1900			115	85	50	50	26.0	98.0	25.0	77.0	30.0	98.0	32.0	98.0	29.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
21/10/1900			115	85	50	50	26.0	98.0	25.0	76.0	29.0	98.0	32.0	98.0	29.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
22/10/1900			115	85	50	50	26.0	98.0	25.0	76.0	29.0	98.0	32.0	98.0	29.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
23/10/1900			115	85	50	50	26.0	98.0	25.0	76.0	28.0	98.0	32.0	98.0	27.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
24/10/1900			115	85	50	50	26.0	98.0	25.0	76.0	28.0	98.0	32.0	98.0	27.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
25/10/1900			115	85	50	50	26.0	98.0	25.0	75.0	27.0	98.0	32.0	98.0	27.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0
26/10/1900			115	85	50	50	26.0	98.0	25.0	74.0	27.0	98.0	31.0	98.0	29.0	90.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0	98.0	32.0

Total: 0 0 Hrs Month & Year: October-2002

Figure 1 Humidity log report

However, conventional log forms, as shown above (Figure 1), do not provide information on dew points and do not warn the crew if condensation is taking place. They therefore do not give effective performance support, but are widely used in practice.

Dehumidifier plants are fitted on these ships to keep the air dry inside the cargo-holds. These plants have to be maintained properly and operated correctly. Without the information on dew point or moisture content of air inside the cargo hold, it is difficult to operate this system effectively. It is therefore the responsibility of the ship's officers to:

- Understand the process of moisture condensation and dehumidification;
- Monitor and log the dew point
- Be alert to any condensation problems and take preventive measures; and
- Correctly operate and maintain the dehumidification plant.

By constantly monitoring and controlling the cargo-hold humidity, and observing the condition of the cargo when the hatch covers are opened, ship staff can gain an understanding of and experience in dehumidification, and avoid cargo claims.

A support system that can aid the ship's crew in carrying out these responsibilities is discussed below which logs and plots the dew point and warns if there is any impending condensation problem. At the same time it guides the staff in correct operation of dehumidification plant by providing knowledge as and when required using multimedia.

CHARISTRICS OF THE MARINE INDUSTRY

The management and operation of a ship is a specialized and complex process. It is further complicated by:

- Reduced manpower and demanding sailing schedules;
- High turnover of personnel;
- Insufficient time for familiarization with equipment and training; and
- Crew may be transferred to ship with different make or model of machinery.

The industry does take measures to improve technology on board ships as well as to train officers. However, these measures are ineffective if the crew is unable to react appropriately when they encounters a problem.

From what has been discussed above, two major support functions for the ship's crew can be identified:

- Task-oriented specific skills training; and
- On-the-job training and advice.

The characteristics and requirements of the marine industry, discussed above, suggest the suitability of an Electronic Performance Support System (EPSS) approach. The multimedia software program "Performance Support for Cargo Hold Humidity Control" provides such an aid.

PROPOSED SOLUTION

Developments in computer technology are rapidly changing the ways in which information is distributed and retrieved; knowledge and expertise is stored and acquired; and skills are learnt and transferred. This has important implications for engineering training and skills development to meet the challenges of handling complex plants and equipment (Banerji and Bhandari, 1995). The advent of multimedia technology has led to numerous new approaches to learning and information delivery. These resources can be amalgamated in a suitable way to create a multimedia EPSS (Electronic Performance Support System). The purpose of an EPSS is to provide training, information and reference material, through a computer, at the point of need or while performing a particular job. It can cut training time by half and greatly reduce human error.

EPSS can be used by a junior engineer new to the equipment, or by an experienced engineer seeking to brush up his knowledge of a particular model of machinery which he may have operated quite some time ago. A multimedia-based EPSS package incorporates the use of text, hypertext, graphics, animation, video, simulation and database to produce interactive performance support solutions. It can also be designed to provide the necessary guidance for performing a task and delivering document information.

USER PROFILE

The main user group would be the senior management personnel, namely the Master, Chief Officer, Chief Engineer and Second Engineer, on forest product carriers. The users should have a marine engineering background, understand the importance of humidity control, operating and maintaining the dehumidifier, and have sufficient English-proficiency to follow the instructions in the EPSS.

BENEFITS

There are several benefits of a computer-based EPSS:

- Readily available and consistent information;

- Reduced training time and training cost;
- Better understanding of tasks and improved performance by ship's crew; and
- Reduced errors in operation and safe carriage of expensive cargo.

OBJECTIVE OF EPSS

The objective of this multimedia program is to support the ship's crew in controlling the dew point and preventing moisture condensation in cargo-holds. It provides information and guidance on the:

- Cargo and its characteristics;
- Dehumidification plant and its operation;
- Emergency procedures;
- Monitoring dehumidifier efficiency;
- Plant maintenance and fault diagnostics.
- Experience capture from past voyages

It contains an electronic manual with a search function for quick reference. A TIPS feature allows the ship's crew to record their experiences and comments as a guide for the next crew. A cargo-hold dehumidification simulator is also provided for the ship's crew to explore how moisture condensation can be avoided.

DEVELOPMENT PROCESS

The ADDIE methodology provides a clear process for designing, developing and implementing a performance support system. This model was adopted to guide the project development.

ADDIE stands for:

Analyze:

- Analyze target trainees
- Analyze performance needs
- Analyze work environment
- Study existing procedures
- Identify overall goal
- Identify objectives

Operation research is done to determine most efficient way to do the task. Task performance analysis is carried out to determine the performance gap. Support system is then designed to address the performance gap. Misconceptions in the mind of the crew are discovered and cleared.

Design:

- Design Macro strategy
- Design Micro strategy
- Design learning activities
- Detail storyboard Produce graphics list/description
- Produce audio list/scripts
- Produce video & animation list/scripts

Who doesn't need help with their work? Performance support is a solution designed to help a person do his task better, by providing information and guidance when and where and how he needs it. Support strategy is worked out most appropriate to the task.

Develop:

- Develop database & task support program
- Develop graphics
- Develop animation
- Develop video Develop audio
- Develop other media
- Integrate all media
- Run Pilot Test

EPSS is developed to provide information, guidance and support using visual, Audio, Text in a right mix which seafarers are most comfortable with.

Implement:

- Put the plan into action.
- Implementation requires training of end user,
- Installation on board ship and doing test runs.
- Some fine tuning may be required after implementation.

Evaluate:

- Evaluate the plan from all levels for next implementation

CONTENT OF EPSS

After carrying out an analysis, following content outline was developed:

1. Introduction - Why do we need to control humidity in the cargo space while transporting forest products; what are the consequences if humidity is high; and the need for ship staff to be trained and vigilant.
2. List of Cargo that is susceptible to damage from condensation.
3. Basic Theory - what is dew point, relative humidity and moisture content.
4. Simulator - For better understanding the relationship between ambient temperature, dew point and relative humidity.
5. Working Principle of the dehumidifier.
6. Installation overview - to familiarize with the dehumidifier, its main components and their features; and overview of installation showing cargo space, air ducting and isolating flaps.
7. Ventilation arrangement - External air input and recirculation.
8. Air circulation strategy in cargo-hold for steel rolls and paper pulp.
9. Instrumentation - RH measurement instrument, test and calibration.
10. Fault Diagnostics
11. Electronic Documentation - Manual in PDF format.
12. Starting the dehumidification plant.
13. Watch keeping - Temperature and humidity data recording and trend plotting.
14. Stopping the dehumification plant in a safe manner.
15. Emergency - Stop operation in case of fire in cargo hold.
16. TIPS - Experience capture and knowledge support tool.
17. Reports- Log report for charterers and history of humidity records

INTERFACE DESIGN

"I will not use this program." This is the user reaction that software developers fear the most. Research shows that 86% of people who decide not to use a recently purchased/installed programme do so because of the interface. A key element of performance support is the way in which the user communicates with the computer and vice versa. Great effort needs to be devoted to the design of performance support interfaces. - Dr.Beatriz Beltran

The main screen (Figure 2) functionality requirements are:

- The screen architecture (structure) must remain consistent within an application;
- The screen elements should be easy to find and use;
- "Clutter" must be minimized in screen real-state use;
- Menus and data-input forms should be easy to use; and
- The functions of buttons and other controls should be communicated by their appearance.

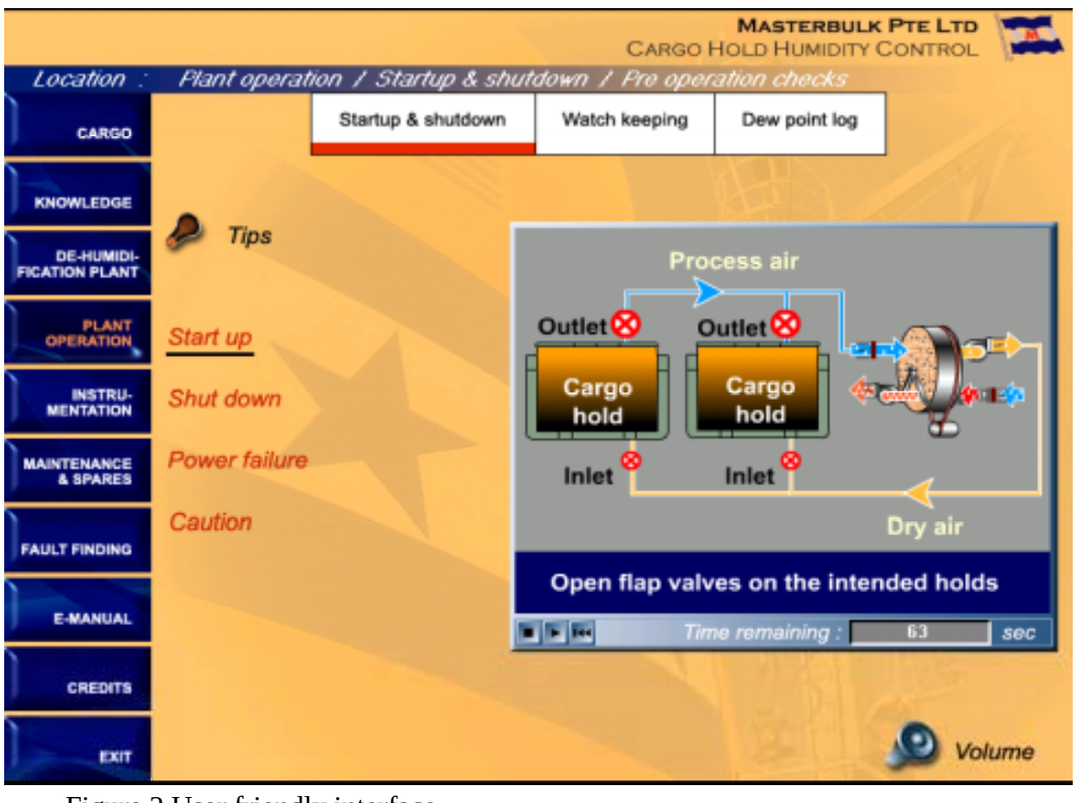


Figure 2 User friendly interface

DATA RECORDING

There is a specially designed form (Figure 3) for entering temperature and relative humidity data. The form gives visual warning of impending condensation and also plots the trend of dew point in the cargo-hold.

The graphical dew point display (Figure 4) makes it easy to follow the moisture condition in the cargo-hold and promotes vigilance among the crew.

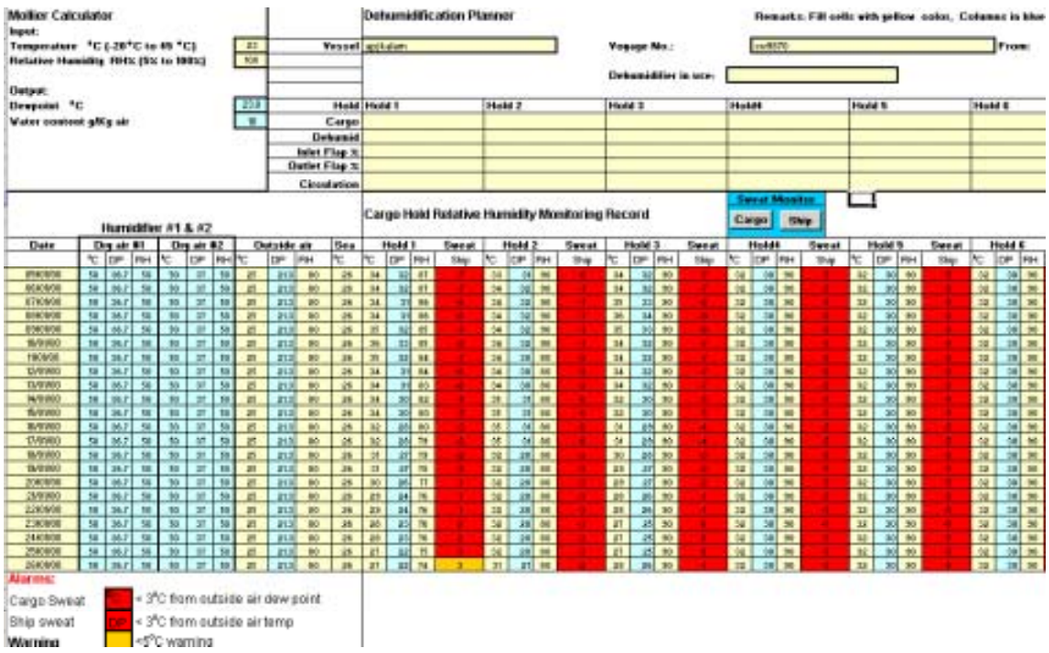


Figure 3 Humidity data entry form

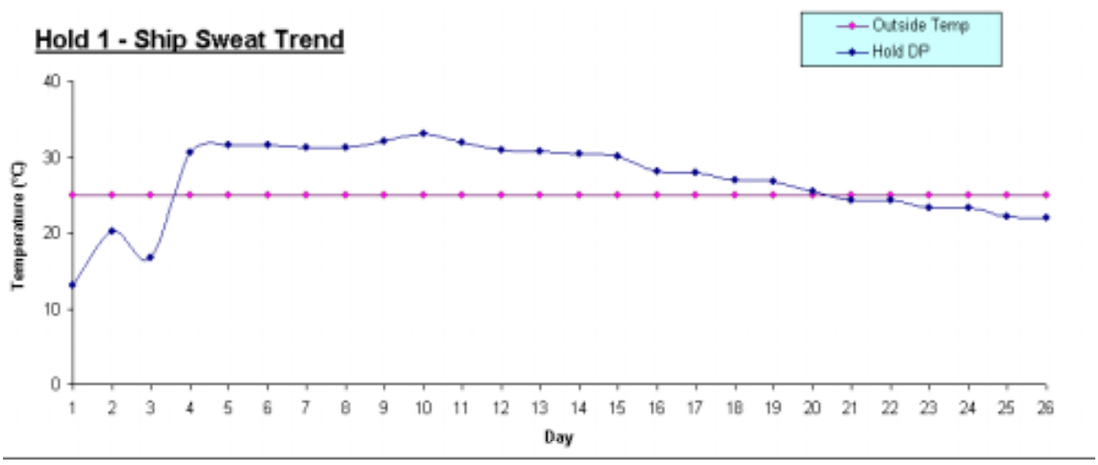


Figure 4 Graph showing cargo hold dew point and outside temperature trends

KNOWLEDGE SUPPORT TOOLS

"There is nowhere else to look for the future but in the past." - James Burke, Connections

To transfer knowledge from those who have it to those who need it, a TIPS feature has been provided in the EPSS. The ship's crew can record their experiences and comments for effective re-use by the next crew, as and when they need it. The knowledge is categorised such that the right information is available at the right time.

For administrative purposes, the Chief Officer is authorised to enter, edit or delete a particular tip. History of voyage records is maintained for reference. These reports contain temperature, humidity data for cargo holds as well as dehumidifier. This information is useful for new sea staff to know the capability of the system and the optimum settings of temperatures, ventilation flaps etc. Officers can compare records with "best humidity control practice" with those, which resulted in moisture damage of cargo and aim to optimize their cargo ventilation operation.

Figure 5 Historical records of voyages

FAULT DIAGNOSTICS

This module (Figure 6) takes the user step-by-step through the faultfinding procedures required to diagnose a range of problems, possible causes and remedy connected with the dehumidification plant. It is also linked to the chapter on fault-finding in the electronic manual.

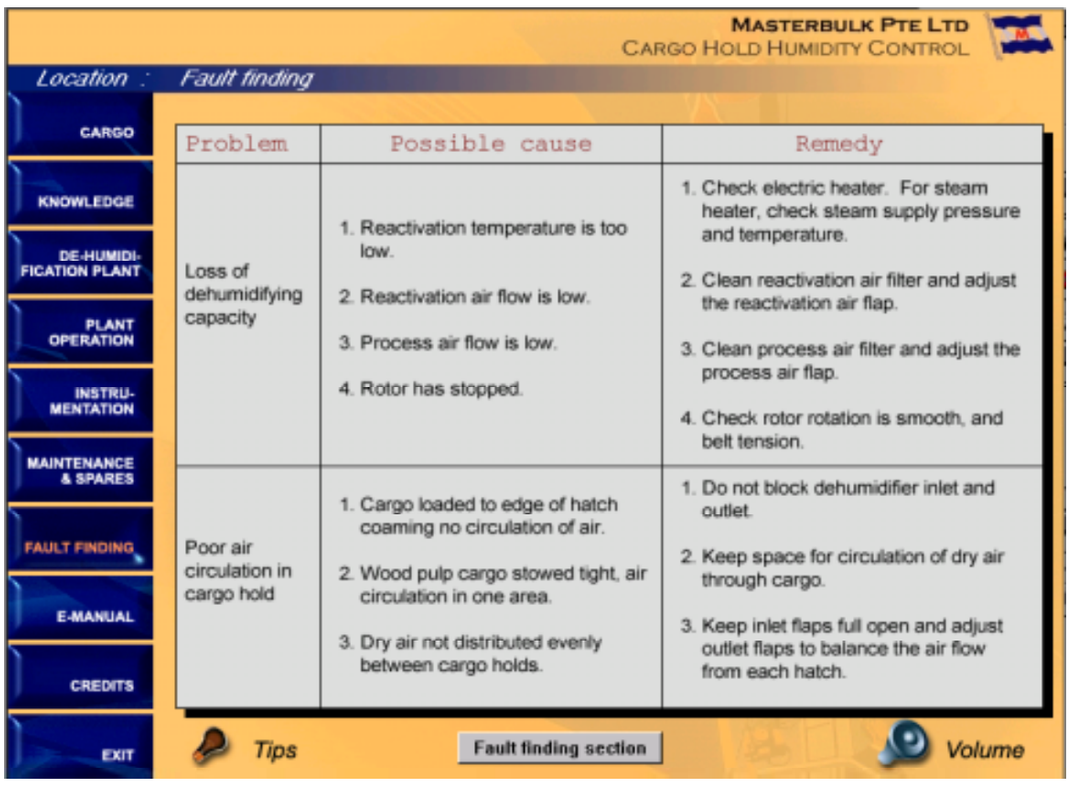


Figure 6 Fault finding chart

SIMULATOR FOR INTERACTIVE LEARNING AND DCISION MAKING
The simulator is a tool that facilitates learning by engaging the learner in an interactive experience. The ship's crew can simulate changes in temperatures and relative humidity inside and outside the cargo-hold and receive information on the dew point and moisture condensation on a Mollier diagram as well as by visual presentation. This information can then be used for learning or for decision support in cargo-hold ventilation.

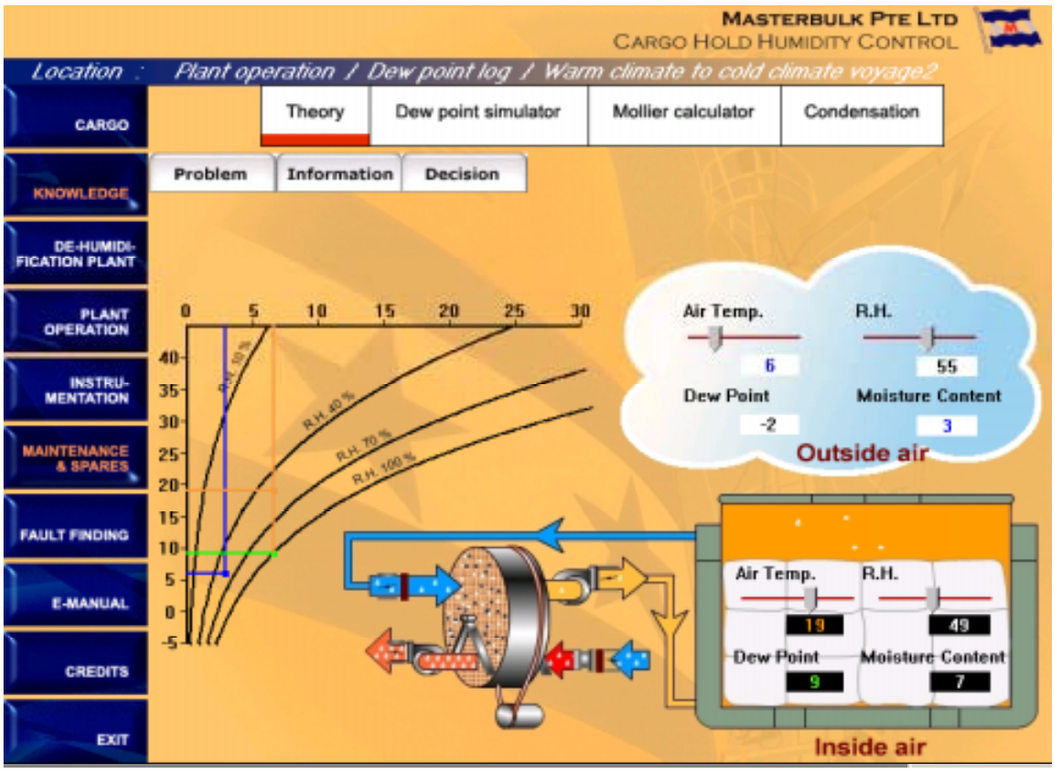


Figure 7 Simulator for learning and decision making

CONCLUSION
The main aim of this performance support system is human - task interaction in which computers and people attempt to control cargo ventilation in a cooperative way. Computers are used to provide an external memory, consistent information, a history of temperature/humidity data throughout the voyage, and TIPS. The system hides irrelevant material, and summarizes and visually presents relevant information. In effect, the computer system acts as an expert whom user can consult to help do the job better. By adopting such an EPSS approach, shipping companies can ensure the competency standards of their management and operations personnel, and support their just-in-time training needs, for safe performance.

Note: This paper was earlier presented at International Conference on Port and Maritime R&D and Technology, "Challenges for the next decade" 10-12 September 2003, Singapore

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Banerji A. and Bhandari, R., (1997). Designing EPSS for Marine Industry.