

## TOOL DEVELOPMENT AND INTEGRATION TO ACHIEVE CLEAN, SAFE AND EFFICIENT TRANSPORT

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### SUMMARY

Achieving clean, safe and integrated transport requires the integration of a set of tools, each targeting different aspects of sea transport. Management Science techniques have been developed and processed in tools to improve the safety and economy of maritime transport. These tools are described in detail, outlining the novel features. In addition, the interactions between the tools currently implemented, as well as those being developed, are discussed. Furthermore, new tools being developed are discussed. Integration of all these tools will result in a real time, single package guaranteeing clean, safe and integrated transport. Research into the economic benefits show cost saving of 10% to 20% on variable costs.

### NOMENCLATURE

The symbols, abbreviations and acronyms used in this paper are given below.

[Symbol/Acronym]	[Definition]
CPC	Cargo Planning Computer
CrewPlan	CrewPlanning
DockPlan	(Dry) Dock Planning
EcoTrim	Methodology to optimize trim
Famon	Fatigue Monitoring
FleetPlan	Fleet Planning
ISMS	Integrated Ship Management System
MQK	Marine Quality Kit
SafePlan	Strain Analyses Fatigue Engineering
SafeTrans	Standard for transport engineering and voyage planning

### 1. INTRODUCTION

Since 1986 HMC is involved in the development and implementation of planning and optimisation systems, i.e. management science applications, for the maritime industry.

Systems have been conceived systems for cargo stowage, voyage preparation, crew planning and fleet planning. Optimisation of any of these operations requires careful consideration of the effects on the other operations. Route optimisation can for example result in untimely arrival of the cargo and would therefore require integration with a tool optimising the time-scheduling of fleet and cargo.

To date no integrated system is available taking into account all relevant aspects of fleet operations.

Strengthened international legislation further increases the demand to integrate measures such as minimisation of fuel consumption into the planning of the maritime operation.

A process has started the process of integration of tools [1] in each of these fields with the objective of delivering

an integrated system, as described in this paper.

In order to aid clean, safe and efficient transport, HMC has developed the following tools, including systems for cargo stowage, voyage preparation, crew planning and fleet planning:

**SafePlan** [2] is our suite of tools to calculate hull and cargo structural integrity information under fatigue conditions during transport and the effect of actions such as route changes and changes in speed. It contains:

- Fatigue Monitoring System (FAMON), which consists of strain and acceleration sensors in a fixed Hull monitoring system, or mobile configuration (the Marine Quality Kit, MQK). The last can also determine fatigue of the cargo. In addition, it contains fatigue algorithms performed in an on-board computer, the results of which are reported to the crew and stored.
- Our loading computer, CPC 2.0.

The **CPC 3.0** loading computer uses a meshed hullform to enable actual calculations in finite element approach. This furthermore enables coupling the tool with our other tools.

CPC calculates longitudinal strength and stability for a given cargo configuration. The use of a class approved loading calculation provides the opportunity to load the ship in a safe and stable way, thereby reducing risks to ship and cargo.

**EcoTrim** determines the optimal trim of the vessel to reduce both the frictional – and the wave making resistance, thereby reducing the fuel consumption.

**DockPlan** show the critical path in docking a ship, thereby giving a better insight in the time-scheduling.

**StowPlan** [3] has a main target the minimization of the number of re-handles during stacking of containers. This tool is applied to both stowage – and yard planning. StowPlan is part of Cargo Planning and it will optimise the stowage of containers, by minimising the amount of rehandles.

**FleetPlan** can generate optimised Fleet schedules on a daily basis with a horizon up to several months to be specified by the user for each commodity and ship type. FleetPlan incorporates an optimisation algorithm that generates optimised Fleet schedules. The user can adjust a schedule generated by FleetPlan, in an interactive manner; FleetPlan reverts with messages whether manual adjustments are feasible. The system can save and reload previous generated schedules for comparison purposes.

**CrewPlan** incorporates an optimisation algorithm that generates optimised crew schedules. The user can adjust a schedule generated by CrewPlan, in an interactive manner; CrewPlan reverts with messages whether manual adjustments are feasible. The system can take into account the previous schedule in order to minimise changes when one person needs to be re-scheduled.

The **WorksPlan** system comprises the development of a simple, user friendly system including the following activities:

1. certificate control;
2. planned maintenance;
3. inventory control.

The environment of the ship can of course influence the overall ship performance and the way crew works and performs. Data of the state of the environment also play an important role in the operation of ISMS. Certificates of personnel, certificates of the ship or rules are not the same in every country. The seastate and for example the weather are not always the same and can also influence the overall ship performance.

The diagram below illustrates how a number of the tools that HMC markets can be combined in order to minimize and monitor fatigue, as well as minimize fuel consumption. HMC uses this process in-house. SafePlan is used to prepare, perform and process the results of fatigue measurements. SafeTrans is used to predict the fatigue build-up during for the voyage considered. Hereby a database of wind - and wave data is used. Combining this with EcoTrim results in a package of tools that can be used to both optimise fuel consumption and minimise trim using both measurement and simulation approaches.

HMC has recognised the importance of keeping up with above described developments. As a result, HMC's long term objective is to develop an Integrated Ship Management System. This ISMS will be an integration of different modules or components. Some of these components are still in development. However, the main goal is to integrate these components in such a way that the different components and data (like environmental data) will co-operate into one overall system, the ISMS. This ISMS is shown in the diagram below.

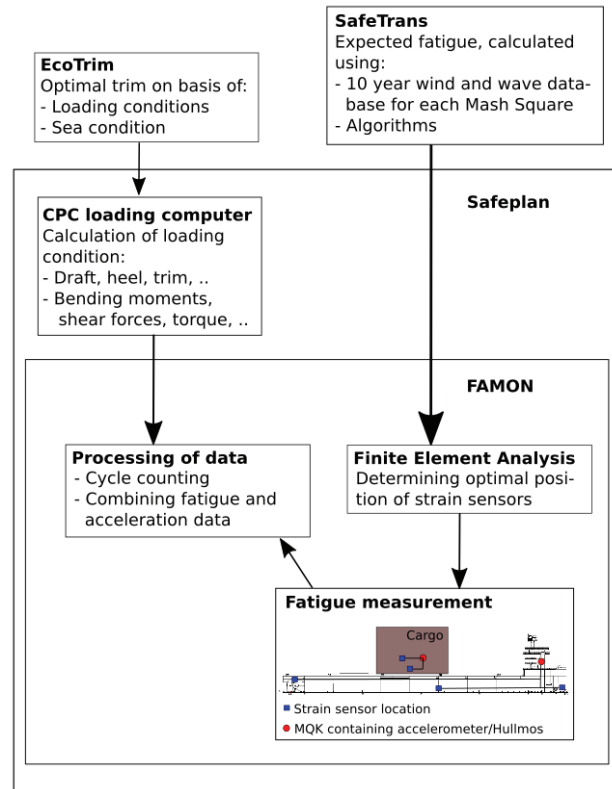


Figure 1: Minimising and monitoring fatigue and fuel consumption

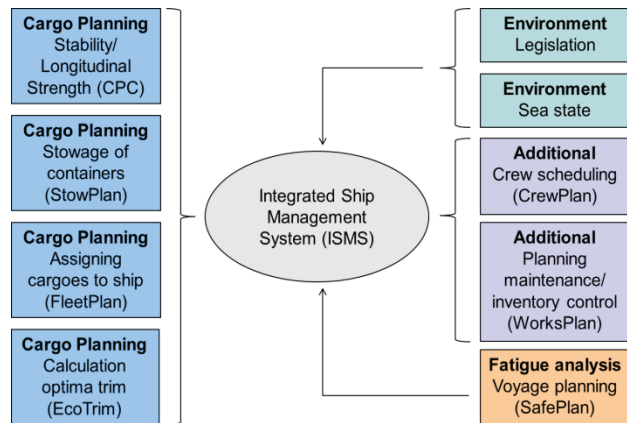


Figure 2: Structure of the Integrated Ship Management System

These components and the collected (environmental) data will be integrated in such a way that they co-operate and coincide into an overall integrated ship management system. This integration requires a complex database, which is presently being developed. The Integrated Ship Management System (ISMS) is the database which combines all data from the tools, resulting in a sophisticated decision support system.

## 2. SAFEPLAN

### 2.1 MOTION, STRAIN AND FATIGUE MEASUREMENT

Addressed under the acronym SafePlan. SafePlan (Strain Analyses and Fatigue Engineering in Ocean Transportation and Towsages) is a suite of systems consisting of a number of applications. The programs inside SafePlan are installed on all kind of heavy-cargo vessels and other ships.

SafePlan measures the actual stresses and motions which makes the system a unique combination that does not exist. The package consists of the following elements:

- Fatigue Monitoring system FAMON
- Hull monitoring system
- Mobile strain, motion and fatigue measuring system. Marine Quality Kit (MQK)
- Cargo Planning and loading Computer CPC 2.0

### 2.2 IMPROVING SAFETY OF HEAVY TRANSPORTATIONS

The suite is developed to simulate the consequences of actions such as route changes, the effect of speed reductions and course changes under harsh conditions. The use of SafePlan as a decision support system will increase the safety of transports. The system will be able to monitor and safeguard the actual state of the vessel and cargo during transportations.

### 2.3 OFFICE AND ON-BOARD SYSTEMS

The available office system is a suite of computer programs with a graphical user interface, which computes the design values for a transport and acts as a safeguard system. Our on-board system is a decision support and monitoring package designed to support the crew by providing information for operational and routing decisions.

### 2.4 UNIQUE

SafePlan is unique in measuring and processing stress, motions and fatigue data. Combining these data enables rigorous analysis and eliminates errors and incorrect assumptions which are easily made in conventional measurement systems. It calculates hull stress, guards motions and calculates fatigue. Furthermore it also registers the environmental conditions. Through Routegen (data with remote sensing) and Wave Radar, the registration of current data (confirmation of the weather forecast) SafePlan can be used as a decision support quantifying probabilities and thus reducing operational risks.

### 2.5 COMBINING FATIGUE AND MOTION DATA

By combining fatigue damage data and motion data, SafePlan allows its user to relate fatigue damage to certain operating areas and different types of weather conditions. Weather conditions around the Cape of Good Hope are entirely different, and therefore have an entirely different effect on the fatigue life of a ship than seas in the vicinity of the Middle East. Combining fatigue, motion and a ship's position allows the user to build a database and predict a ship's fatigue life more carefully by relating fatigue damage to specific areas and seasons.

### 2.6 FATIGUE MONITORING SYSTEM (FAMON)

#### 2.6 (a) Fatigue calculation

When a heavy transport object is shipped by sea, irregular cyclic loads will act on this object. In some cases these loads will cause fatigue damage. Little is known with respect to the actual level of fatigue damage sustained during a transport. In order to quantify the fatigue damage, a gauging system has been developed which can be mounted at a location on the object which is expected to be sensitive to fatigue. The system records the strains in the gauges as time traces. Moreover the system calculates a rate of fatigue and the fatigue accumulation during the voyage.

### 2.7 HULL MONITORING SYSTEM

#### 2.7 (a) Real time strain information

HMC's Hull monitoring system is a real time measuring device that monitors the on-board stresses, forces and the fluctuations of the hull. The system helps the captain and the owner of the ship to gather data to reduce the risk of damages. When the data is made available directly on board, it enables the captain to change his speed or heading to diminish motions and fatigue damage.

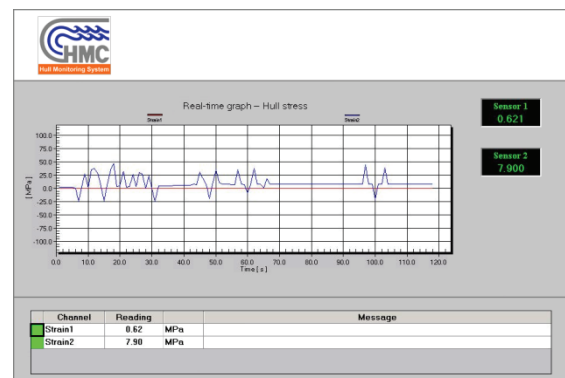


Figure 3: Read-out of sensors

## 2.7 (b) Stand-alone or in a bridge system

Hull Monitoring can be used either as stand-alone monitoring system, or integrated in a complete bridge information system. The system includes an alarm system for the crew in case the pre-defined design and operational strain and/or motion limits are exceeded. The system processes and displays the information to the officers of the vessel for operational purposes.

The information displayed to the bridge includes:

- Structural strain, stress and fatigue
- Motion Fluctuations
- Real time deflection
- Translation to stress & bending moment
- Check with maximum allowable bending moment
- With the system the MONHULL notation can be obtained



Figure 4: Hull monitoring system installed on-board of the semi-submersible heavy cargo vessel Fairstar Fjord

## 2.8 ADVANTAGES

Our Hull monitoring system offers the following advantages:

- It offers the possibility of reducing hull repairs and the risk of damaging cargo.
- It provides data to plan ship maintenance, minimising condition-based maintenance and supporting the classification process.
- Empirical measurement results of the system may result in the optimization possibilities for ship constructions and the reduction of costs.
- The system promotes the safety of vessel, cargo, passengers and crew by allowing the officers to reduce hull strain and increase the durability of the hull.
- It enables the officer to operate the vessel prudently.
- It provides data to estimate the fatigue life of the hull; moreover, this data can be used to improve the design of new vessels.
- The system can be connected with the VDR.

- Finally, the system acts as a recorder, which enables owners to monitor the handling of their vessel.

## 2.9 MARINE QUALITY KIT (MQK)

### 2.9 (a) Monitoring of strain, fatigue and motion behaviour of floating objects

Parallel to our Hull monitoring system, HMC developed the Marine Quality Kit (MQK) as a portable strain, motion and fatigue measuring system. Where the Hull monitoring system is installed on a ship to serve the ship's lifetime, the MQK is easily installable and removable on any given structure. The MQK is designed to measure strain and gives the opportunity to calculate fatigue life of structures like seafastening or project cargo.

The MQK measures accelerations and strain. In combination with FAMON fatigue measuring and monitoring software it also provides an owner or contractor with fatigue data. An accelerometer is added to combine real-time strain and motion data with sea state conditions and allow the crew to adjust speed and heading to lower the stress on a structure.

The system can be used either as a measuring device for post-hoc readout and analysis, or as a real-time monitoring device. In this last set-up, information is sent to the bridge via a wireless connection.

### 2.9 (b) Data

The system saves all strain and motion data in corresponding directories. It is also possible to log all real measured data by turning LOG ON. The system will show all measured data real-time on screen. Raw data will be processed and analysed by HMC and delivered as a measuring report. The MQK is a useful tool for ship-owners, marine surveyors, insurance industry, contractors and their respective clients.

## 2.10 CARGO PLANNING AND LOADING COMPUTER (CPC 2.0)

### 2.10 (a) Stability & Longitudinal Strength Software

CPC 2.0 is HMC's solution for class approved ship stability and loading calculations. This Cargo Planning and Loading Computer includes all obliged stability and strength parameters in an efficient and user friendly interface. CPC 2.0 is based on CPC 1.9, which was installed on over 1500 ships worldwide since its first delivery in 1980. The MS-DOS version of the program was already introduced in the seventies. Key aspect in the development of CPC 2.0 was to decrease the expert knowledge needed to operate the program. This was done by completely redesigning the program and focusing on optimization of the user-interface and visual feedback



## 4.2 BACKGROUND

EcoTrim displays the optimal trim for a vessel in the respective loading conditions. In theory, under ideal conditions, fuel savings up to 5% can be achieved. In reality, these savings will be around 2 - 3%.

## 4.3 SPECIFICATIONS

EcoTrim uses the integrated hullform of the vessel to determine the most optimal resistance curves with a certain trim to minimize the fuel loss due to an inefficient loading condition.

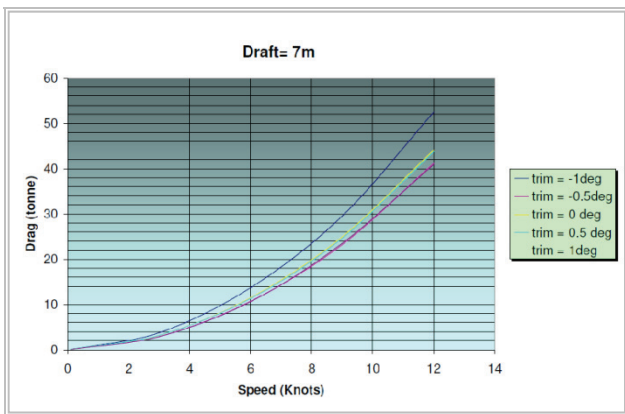


Figure 7: Relationship between Drag, Speed and Trim. The most ideal relation: -0.5deg at 8.5-11 knots.

## 5. DOCKPLAN

### 5.1 DOCK ADMINISTRATION AND PLANNING SOFTWARE

Docking periods are mandatory downtime periods which only cost money to operators and owners of vessels. As the complexity of and demand for special ships increases, an hour of downtime gets more and more expensive. It is therefore crucial to reduce downtime due to docking and maintenance periods as much as possible. This is where the software program DockPlan comes in. DockPlan keeps track of all required maintenance activities, materials and skills needed to complete a job. Via a sophisticated algorithm, a critical path of planned activities is determined. The effect of changes and delays to the planning are directly visible and can be acted upon immediately.

### 5.2 DOCK PLANNING

During docking periods a lot of maintenance activities are executed in parallel fashion to ensure the shortest docking time of the vessel. This however increases the complexity of the operation and easily allows for mistakes to be made. Mistakes lead to delays and delays cost money. Dock planning is therefore of utmost importance to increase efficiency and transparency of the docking operation.

## 5.3 PROBLEMS

DockPlan is a web based planning and decision support system to avoid expensive planning mistakes and delays. The program is web based to enable access to data from both the office as well as on site. DockPlan supports decision-making by providing transparency to the critical path planning. A critical path is an interlinked flow of all possible “bottle-necks” of the dry-docking operation. In practice, if one of these bottle-necks is delayed, it will delay other activities in turn due to its interdependencies. This second delay will cause other maintenance activities to delay and a chain link reaction of accumulating delays is the result.

## 5.4 SOLUTION

DockPlan aims to reduce this accumulation of delays by providing transparency to the interdependencies and directly showing the accumulated delay if one bottle-neck activity experiences delay. DockPlan does this through a sophisticated algorithm which automatically calculates the critical path in an interdependent planning. In addition, DockPlan also provides its user with financial consequences; it calculates the effects on costs of delays and downtime to steer the process on financial variables as well.

## 5.5 JOINT INDUSTRY PROJECT

HMC aims to develop DockPlan in close cooperation with shipping companies, shipbuilders and ship maintenance companies. Therefore, a Joint Industry Project (JIP) is commenced to allow the industry to involve themselves in the development of the DockPlan dock planning system.

## 5.6 PARTIES INVOLVED

- Anthony Veder Rederijzaken BV
- Flinter Shipping BV
- Damen Shipyards Group
- Koninklijke Wagenborg BV
- Seaway Heavy Lift
- Dutch Navy

## 6. STOWPLAN

### 6.1 OPTIMISATION ALGORITHM FOR STOWAGE

Since the advent of cargo containerisation some 30 years ago, the shipping industry has steadily continued to evolve. Today there is an increasing share of containers moving under the control of ship operators through several different land and sea transport modes. As the economic benefits of this intermodal network have been wrung out of the system, they have largely been passed on to the purchasers of transportation.

## 6.2 CONTAINER OPTIMISATION

In order to achieve efficiency through economy of scale the size of container ships has increased dramatically. The first fully cellular vessels had a capacity of about 350 TEU. Today there are vessels with a capacity of over 20,000 TEU.

In addition to larger vessels, the economy of scale concept requires large numbers of containers. Since the transfer of containers to and from the vessel is a critical link in the transport chain, it becomes very important that it be carried out efficiently. Port efficiency and vessel utilisation are the main two determinants in efficient loading and unloading. Both are, although quite distinct, largely determined by a common factor; stacking of containers.

In order to gain efficiency in stacking containers HMC developed a planning method, an algorithm. The main goal of the method is the minimisation of the number of rehandles. Up to 10 percent of all containers being handled appear to be rehandles. This refers to the process of replacing the top container in order to access the second originally the method was developed for stowage planning, but it appeared to be useful for yard planning as well. It tries to group containers to port of destination. But at second hand, and this feature is unique, it contains a check that counts the number of future rehandles. This future check is generated by a genius mathematical method. Therefore no containers are placed which immediately lead to rehandles in the future.

The methods used in StowPlan are tested with simulation models and appear to be very effective. In addition, the flexibility of the method leads to a wide range of applications. This includes different kinds of vessels as well as yard planning. Similar phenomena apply for bulk and break bulk cargo

## 7. FLEETPLAN

### 7.1 FLEET PLANNING AND INFORMATION SYSTEM

The FleetPlan application has been developed by HMC in co-operation with Seatrade Reefer Chartering in Antwerp, Belgium. FleetPlan can generate optimised Fleet schedules on a daily basis with a horizon up to several months to be specified by the user for each commodity and ship type. Schedules can be printed in full colour. The flexible database can store a broad range of ship and cargo data. The database can be filled with data from another system using an import module. The database is both applied for storage of historical data as well as for the data required for the generating of the Fleet schedule.

FleetPlan can use several types of information on vessels

and cargoes to schedule these vessels by hand. Cargoes can be planned on vessels using drag-and-drop functionality. A mathematical model is used to generate schedules automatically. For on line positions of the vessels, the user can connect to the satellite communication module. These on line positions of the vessels improve the schedules that are generated by the user or by the system. Each voyage in the schedule is represented by a detailed voyage calculation. All voyage calculations in the schedule are processed into result indicators which give an idea of the quality of the schedule.

## 7.2 OPTIMIZATION ALGORITHM

FleetPlan incorporates an optimisation algorithm that generates optimised Fleet schedules. The user can adjust a schedule generated by FleetPlan, in an interactive manner; FleetPlan reverts with messages whether manual adjustments are feasible. The system can save and reload previous generated schedules for comparing schedules.

## 8. CREWPLAN

### 8.1 CREW ADMINISTRATION AND PLANNING PROGRAM

CrewPlan is HMC's solution for Crew Planning and Administration. CrewPlan features a Gantt chart in which the planning per ship as well as crewmember specific data can be kept, such as on and off times, expiry dates of legal documents, certificates and planning and registry of medical checks. A unique ability in CrewPlan is the automatic schedule check: CrewPlan automatically lists all inconsistencies and warns for future planning problems so that users can act in advance and plan ahead, diminishing planning problems.

### 8.2 APPLICATION

The crew planning application has been developed by HMC in co-operation with the present users. CrewPlan is written for the Microsoft Windows operating system and can visualize schedules with a timespan of about 4 years.

Schedules can be printed for each function, ship or crewmember. CrewPlan also acts like a crewmember database to store a broad range of personnel data.

### 8.3 ISM CODE

CrewPlan can optimise schedules taking into account the requirements pertaining to the certificates of crewmembers. As such assuring that the crew composition is in conformance with the national and international legislation and customer requirements. Thence CrewPlan can be of assistance to act in compliance with ISM code.

By carrying out procedures and processes in a consequent and unambiguous manner using CrewPlan ISM procedures can be simplified.

Certificates and medical tests are monitored and therefore manning requirements can easily be met.

## 9. WORKSPLAN

### 9.1 INVENTORY CONTROL AND PLANNED MAINTENANCE

Due to the increasing number of national and international regulations, companies in the maritime industry are confronted with an increasing number of inspections and certificates to prove compliance with legislation and regulations. Most regulations concern quality, safety and pollution prevention, dictating technical requirements for systems, components and construction. Because of the increasing amount of data concerning inspections and certification, the need for systems that can store data concerning certificates, maintenance and spare parts is evident.

### 9.2 USER FRIENDLY SYSTEM

The WorksPlan system comprises the development of a simple, user friendly system including the following activities:

1. certificate control
2. planned maintenance
3. inventory control

There are systems already developed for these requirements which are extremely efficient and effective. However, the market perceives these systems as complex and expensive, with more functionality than the average user requires. The market would like to see less complex and less expensive systems which at the same time provide benefits similar to those provided by currently existing systems. HMC and her project members are in the belief that they have succeeded in this with the development of WorksPlan.

The WorksPlan system is flexible, straightforward, user friendly, highly beneficial in terms of efficiency and bottom line. The WorksPlan system is based on a database, focussing on:

- certification
- inspections (general and ship specific)
- inspection planning
- planned maintenance
- inventory management, including management of most important and critical components
- additional information on all above-mentioned items

### 9.3 GENERAL

The WorksPlan system is based on a central database that is accessed by three modules (Certificate Control, Planned Maintenance, and Inventory Control). This ensures a minimum amount of input and ensures standardisation of data. The database can be handled via a menu structure.

The system is robust and user friendly so different user groups can effectively use the system. For all items in the database a coding system will be used both according to international standards as well as to specific user requirements.

### 9.4 CERTIFICATE CONTROL

WorksPlan provides the possibility to monitor expiring dates of certificates. More important is to extend or renew certificates in time. In this system you can plan activities and inspection needed. Economical loss when a ship is kept in port due to an expired certificate will then be avoided.

The certificate control module can store the following data concerning certificates:

- inspection planning
- certificate data, e.g. expiry dates, last inspection, data on items concerned and certificate ID
- certifying organisations

The set of certificates needed for the ship can be composed from a default set of certificates that is needed for all ships and additional certificates to be entered by the user.

### 9.5 PLANNED MAINTENANCE

Apart from certificates, the equipment on-board is to be inspected and kept in repair at regular intervals. To ensure that all equipment is maintained on a regularly basis, it is helpful to keep and control the maintenance planning in an automated way. The WorksPlan system offers this possibility.

In this module the user can enter which part is to be maintained at what date. The dates are kept and displayed as in an electronic agenda. The maintenance date can also be connected to the expiry date of the accessory certificate. The user can specify how many weeks before the expiry date he should be noticed. The module can display the specified maintenance planning in different types of output e.g. agenda, bar chart, etc. The planning can be printed for each period of selected time.



## 9.6 INVENTORY CONTROL

To maintain vessel parts in an accurate way it is required to control the on-board inventory of the parts. The Inventory Control module of the WorksPlan system does this in a uniform way, with the possibility of using the market standards in item coding. For example: SFI code, supplier code, article code, etc. The system can help to control the inventory of the most critical items on board a vessel. Besides the identification of the component also historic data is stored, a.o. spares used, resources required etc.

For every item entered in the system the user can control the number in store. The user can specify maximum and minimum numbers in store and will be noticed when these critical values are crossed. The inventory level can be displayed on screen and printed for each item. The database will keep information for each item, like; make, type, quality and a description.

## 10. PROVEN COST SAVINGS

### 10.1 OFFSHORE SUPPLY PLANNING CLUSTER & ROUTE

#### 10.1 (a) Cluster & Route Application

The Cluster & Route application has been developed as a tool for scheduling supply vessels for the offshore industry.

The application can be used for:

- Strategic, tactical and operational planning of supplying offshore installations.
- Cost reduction of offshore logistics.
- Fleet composition.
- Vessel optimisation.
- Pool fleet scheduling.

#### 10.1 (b) Cost reduction and improvement efficiency

Use of the system resulted in considerable cost reduction up to 20% of the variable costs and improvement of efficiency.

#### 10.1 (c) Optimization Algorithm

Cluster & Route incorporates an optimisation algorithm that generates optimised fleet schedules and roundtrips. In optimising the following is taken into account:

- Material requirements of offshore installations.
- Vessel capacity for different types of cargo.
- Costs of the vessel.
- Delivery window for the installations.

The supply schedules state the following for every route to be sailed:

- Vessel name.

- Duration of the route.
- Length of the route.
- Calling order including ETA at the installations.
- Cargo to be carried.

The scheduling algorithm generates a clear report of the sailing schedules for different vessels and the sailing routes are shown in each map in MARPLOT, the geographical interface.

#### 10.1 (d) Geographical interface MARPLOT

HMC planning systems are developed as application under MARPLOT. MARPLOT is a geographical information system that can be used for:

- Displaying the generated sailing tracks of the Cluster & Route planning application.
- Transport engineering.
- Composing your own maps.
- Distance calculations world-wide using standard sailing routes.
- Vessel tracking, displaying the positions of the vessel on-line using the communications module.

MARPLOT is based on a flexible, user friendly database. All kinds of data can be displayed as object in each map in MARPLOT. Additional data can be attached to every object.

## 10.2 PROVEN COST SAVINGS WITH HMC PLANNING SYSTEMS

### 10.2 (a) Using HMC Tools

Management Science is a combination of statistics, operation research and mathematics. HMC specialises in Management Science and Information and Communication Technology Application for the maritime Industry. Case studies proved that considerable cost savings could be obtained using these applications. General conclusion is that variable costs can be reduced by as much as 20%.

#### 10.2 (b) Savings using planning systems

From comparing operations with and without using HMC applications it has been concluded that considerable savings on operational costs had been realised, e.g.:

1. The STAP system, fleet planning system for strategic planning, installed at the Dutch Government resulted in 10% savings on operational costs fleetwide.
2. SHIPPL, fleet planning system for trampers for tactical planning, resulted in 10% savings on operational cost fleetwide.
3. CLUSTER & ROUTE, fleet planning system for suppliers, resulted in 10 to 20% savings on operational costs.

4. HMC's CLUSTER & ROUTE system in comparison with a scheduling system in the US Gulf resulted in 30% lower costs for offshore supply.

#### 10.2 (c) Savings using inventory control and planned maintenance

##### Tanker Fleet Case Study

#### 10.2 (d) Communications

Reduced annual communication costs from \$ 60,000 to \$ 128,000 by using MMS FleetLink with fleetwide e-mail and by using M-sat service. Traditional telex and voice communications were virtually eliminated as part of this new medium.

#### 10.2 (e) Inventory

Realised annual savings on spare parts totalling in excess of \$ 250,000 per ship by using FleetWorks minimum – maximum spare levels, by consolidating freight and by purchasing common parts in bulk. Further savings are being achieved by contracting for future spares based on expected PM routines and storing in warehouse.

#### 10.2 (f) Preventive Maintenance

Reduced annual maintenance costs by over \$ 75,000 per ship. Savings were also realised in casualty repairs and reduced downtime. Fleet has not had a critical breakdown in over two years. Time between overhauls was lengthened to reduce total maintenance and repair cost. The value of downtime prevented runs at least \$ 100,000 per ship per day.

#### 10.2 (g) Regulatory Compliance

By documenting through use of system auditable trials of work procedures, work history, safety measures, and various overhauls, numerous standard class society inspections were met. This prevented lengthy port stays and expensive inspection costs for opening up systems. The procedures also provided the backbone of the fleets ISO/ISM requirements and lowered insurance costs.

Underwater survey replaced two-year hull inspection in dry dock. Divers documented conditions of steel, sea valves, etc. and logged in system with supporting photographic evidence. This saved in excess of \$ 5 million per ship.

## 11. CONCLUSIONS

We have presented a set of tools which when combined can be used to achieve safe, clean and integrated transport.

Combining Engineering tools and Management Science result in improving the overall economics of maritime operations.

Validation studies of the independent tools result in considerable cost savings. Minimum of 10% to 20% on variable cost can be saved.

The integration of these systems is a complex process. But given the possible improvement of operations this integration is an important goal.

Over 30 years of Management Science has been applied in the development of decision support systems, the increased capacity of computers and in combination with more efficient and sophisticated algorithms have made it possible to process comprehensive least time least cost models.

## 12. REFERENCES

1. A.J. BOS M.Sc. MBA Eur.Ing, Hydrographic and Marine Consultants BV (HMC), the Netherlands Integrated Ship Management System, October 2003
2. A.J. BOS M.Sc. MBA Eur.Ing, Hydrographic and Marine Consultants BV (HMC), the Netherlands together with Capt. L.M. Leusink, Fairmount Marine BV, The Netherlands and F.J. Melger, M.Sc., Argoss, The Netherlands; "Strain Analyses and Fatigue Engineering in heavy lift transportation and tows (SafePlan)", the Netherlands, August 2005; Paper presented during RINA conference on Heavy Transportation, Londen, September 2005
3. FLACH J., 'Container Planning', HMC, Almere, the Netherlands, October 1997.

## 13. AUTHORS BIOGRAPHY

Brief biographies are required for all authors e.g.:

**Mr A.J. Bos M.Sc. MBA Eur.Ing** holds the current position of director at HMC BV. He is responsible for the general management of the company, senior consult, senior trainer and guest lecturer at several highly respected technical universities. His previous experience includes a wide range of projects related to improving economics of ship-owners and vessels, build up over more than 30 years of experience in the maritime industry.

**Mr Dr. Ir R. Rosing** holds the current position of Co-ordinator Research and Development at HMC. He is responsible for research and development projects within HMC. His previous experience includes usage and development of simulation programs, modelling of various sensors and development of systems containing electronics and sensors.