ISM demands better maintenance – how do we do it?

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The International Safety Management (ISM) Code has brought auditing to maintenance planning and to risk assessment of machinery. This has been the easy part. The difficult part is how to improve maintenance and reliability, which presumably is what the Code is all about.

PLANNING AND DOCUMENTATION WILL NOT GET THE MAINTENANCE DONE

The ISM demands that we plan and document maintenance. But planning and documentation are in fact what follows a good maintenance culture not what creates it. The converse is like saying that if we have a budget and an accounts department we will have money.

We can all guess that the real target of the ISM Code was to mandate an audited level of maintenance via an audited maintenance plan and then to enforce it by providing the auditor with documentation with which to compare the actual maintenance performed. The Code, when enforced in the area of maintenance, will certainly succeed in bringing maintenance to the attention of top management especially if audits create problems with ISM compliance.

ARE MAINTENANCE RELATED NON-COMPLIANCES A SIGN OF POOR MAINTENANCE?

There are two main problem areas that can result in maintenance related non-compliances, even under the most ideal ship maintenance culture. These are:

- Poor adaptation of the maintenance plan to the condition of the vessel, and
- A failure in gaining the auditor's approval of the plan.

The first problem will arise with a maintenance plan that does not truly reflect the requirements of the vessel, resulting in a lot of unexpected maintenance and falling back of scheduled maintenance. This situation will almost be guaranteed if the vessel was recently purchased, even if this is after the allowed six-month moratorium on ISM compliance (i.e. under the provision of the Interim SMC). Some examples of unpredictable problems might include:

- How can one plan the maintenance of an engine room that is unfamiliar?
- Can reliability of automation and safety shutdowns be foreseen?
- Can pipe leaks be foreseen and preplanned?
- Can the internal condition of machinery and the quality of past maintenance be assessed from maintenance records obtained from previous owners?
- Can unfamiliar machinery designs be assessed as to their reliability and need for maintenance, when the manufacturers themselves do all they can to avoid admitting or even assisting in the trouble areas of which they are often aware?

The second problem area will be having a maintenance plan that has not been approved by the ISM auditors. This situation will result whenever an auditor believes that certain maintenance intervals are appropriate and the owner disagrees with this. There have already been arguments between owners and auditors on the subject of any deviation from manufacturers recommended service intervals and certainly there is a huge scope for disagreement if we are to consider that accurate service intervals are condition and risk related and not purely running time related.

The conclusion we can draw, is that maintenance plans that can be followed without non-conformities and without disagreements with auditors, are plans performed on machinery on which considerable experience has been gained, and which no longer shows any unresolved trouble areas and which is properly operated.

CONDITION ASSESSMENT AND RISK ASSESSMENT

ISM also requires that items of machinery, which by failing can create acute safety risks, must be adequately identified, inspected, maintained, documented and, by implication, provided with adequate spares.

Presently, a number of classification societies are reconsidering their Continuous Machinery Survey intervals and replacing them with the concept of condition and risk assessed intervals, so as to closely match maintenance with condition and overall safety risk of machinery failure. This is an excellent concept but it is extremely difficult to implement in the real world. This is because it is very difficult to assess the probability of failure unless: (a) the detailed history of operation and maintenance of each item of machinery is known and, (b) decades of accurately recorded multi installation experience exists for the machinery in question.

Also we know that class mandated inspections are a very small percentage of maintenance requirements and if only these surveys are condition and risk assessed it will not provide much useful guidance for a full Planned Maintenance system. The only immediately useful application of this new class method is in the reassessment of maintenance intervals of main bearing and other main engine running gear surveys, which are notorious for causing unnecessary vessels' downtime.

The conditions which will routinely cause risk on a vessel are: poor previous maintenance, poor operating conditions and procedures, and all the consequential effects of these. For example, leaking pump seals cause corrosion of bolts and piping, inadvertent rising of bilge levels in ports, fire hazards, smearing of bilge area equipment and corrosion and prolonged dismantling times. Other examples are previously poorly maintained generators, compressors, main engine, coolers, turbines, instrumentation, settings etc. Also, poor operating conditions such as insufficient cylinder oil, poor maintenance of lubricating and hydraulic oils, poor maintenance of cooling and boiler waters, poor fuel atomisation, poor level control in boilers, poor water separation in turbine equipment, air leaks in refrigeration equipment, etc. The results of these conditions even if they occurred some time in the past continue to affect the maintenance and reliability of a vessel, and these conditions take a long time to assess unless they are known to have occurred.

Unfortunately these situations are not rare and the ISM record keeping requirements will help very little an owner who buys a vessel that has endured such conditions. Also risk and condition assessment as planned by class societies will help very little because it pertains to a small percentage of the machinery and cannot possibly quantitatively allow for variations in previous operating conditions, latent defects etc. In conclusion, to assess the probability of failure we need a lot of information as to the historic operation and maintenance of all the machinery on a vessel. Although ISM mandates proper record keeping, it will take many years to accumulate such records so as to guide operators on previous history, and the type of record keeping is unlikely to yield much indicative information of poor operation. However, the ISM Code will to some extent give more grounds for the suspicion of poor conditions in the past, and may in this way provide a new owner with more information on which to better judge the condition of a vessel to be purchased.

COMPUTERISED PLANNED MAINTENANCE AND PARTS CONTROL SYSTEMS

Computerisation of Planned Maintenance systems can only work if the above mentioned criteria have been satisfactorily met. In other words, unless the machinery operation is entirely predictable, any Planned Maintenance system will in itself introduce many non-conformities and plan deviations. Computerisation of Planned Maintenance systems is presently quite popular because office personnel and quality managers feel the need to be able to view maintenance progress so as to avoid ship detentions as a result of potential non-conformities.

However, the computerised Planned Maintenance Systems presently available in the market are complicated workflow systems that have not shown benefit to the main users on the vessels and are thus often poorly updated by them. The reason that they do not greatly assist in the area of planning is they cannot be programmed to know the **condition** of all the hundreds of pieces of machinery and dismantling tools on the vessel, nor the priority of maintenance that a reasonable Chief Engineer knows intuitively and without any difficulty. Instead of prescriptive maintenance scheduling, a Chief Engineer would prefer a system which is of an advisory and informative nature, and which also adjusts according to the practical priorities dictated by the experience and the constraints of the Chief Engineer.

Also, the Parts Control of existing computerised systems is such that it is easier to maintain an inventory by controlling access to the spares store rooms (with padlocks), and by actually visually verifying the existence on board of critical parts needed for imminent maintenance, than to rely on a computerised inventory without graphical facilities that is only as reliable as the care with which it has been updated. Even the expectation of omissions in the updating, requires the Chief Engineer to verify by checking the storeroom long before the maintenance is performed, thus rendering the computerised inventory as a guide of limited reliability. Existing Planned Maintenance systems do however guide office personnel on the issues of administering maintenance and parts control especially now that ISM has set criteria for this.

Therefore Planned Maintenance systems come in two main categories. The ones that assist the office in administering maintenance and parts control, and those that do not yet exist, which will assist the on board crew and thus will be maintained and respected by them.

In both cases it is imperative that the system is easy to use because in both cases it will be used onboard where the turnover is very high and any change in Chief Engineer introduces the risk of system omissions, a situation that is tolerable for maintenance planning but intolerable for parts control.

Obviously it is desirable to introduce Planned Maintenance and Parts Control Systems that significantly help the people on board. To achieve this the targeted features are:

- Workflow, such that: the normal sequence of actions which engineers on board follow in practice in planning maintenance and parts control are accommodated. This means that, for example, jumping from maintenance instructions, to records of previous maintenance, to parts diagrams, to current orders, to inventory, and then to a requisition facility. It should be possible for all this to happen without entering part numbers twice and without losing track of the originally entered maintenance component.
- The manual of the manufacturer can be incorporated in the PMS system, which will greatly assist the Chief Engineer in the area of searching for critical data especially during emergency diagnosis. How many times have you come across breakdowns that could

have been avoided had the Chief Engineer had access and proper understanding of information relevant to the machine?

- Graphics must be used to eliminate many confusing steps in the parts identification, parts control and requisition approval processes.
- Linking company Standing Instructions to Maintenance Component, such that: the Chief Engineer can see critical office communications at the same time as he plans maintenance or orders parts.
- A host of other features that ensure adequate ergonomics to minimise: training, related omissions, complaints, and constant coaxing by the technical department to ensure that on board engineers use the system.

Therefore, ship managers must elect to computerise only when the software in question can convince new users that the software is easy to use and also is highly beneficial. As to computer literacy, the level of computer literacy necessary for well-designed user-friendly programs will be low and will not be an obstacle to widespread use. However, such user-friendly software has not existed in any industry in the past for a number of technological reasons. So, whereas in the past software was invariably full of codes, unfamiliar functions and non-intuitive ergonomics, today, it is possible to make it entirely lucid and obvious even to the most infrequent user. To conclude, from now on if computers are to be used in more widespread areas of shipping, the software must be people literate the people being computer literate. It is the software designers that must retrain in how their clients think and work rather than clients training to learn how computer programs work.

This requires a fundamental change in programming philosophy for software producers.

Computerised Communications and Information Dissemination

When our company addressed the prospect of compliance with the ISM Code three years ago, it was concluded that it would be necessary to employ a computerised system. Having resisted office computerisation in preceding years, it was realised that the now much cheaper computer memory, plus the power of computers to file and retrieve large volumes of information is the way forward for an ISM support system. The basic requirements envisaged were:

- To make it easy and fast for a user to locate all relevant entries in the company manuals for any given task;
- To create a system which would administer the expected large volume of documentation (and its traceability) required by the Code;
- To establish a platform for the dissemination of information (applicable codes, guidelines, recommendations, IMO Resolutions, company instructions, etc);
- To address the problem of filing (and retrieval) of information;
- To take advantage of today's technology for speedy and economic communications.

Some related questions we asked ourselves were:

- How many times do we read things that we would want to refer to at some other time in the future and need to think of where to file them so as to find them at the time of need?
- How much time do new people, like crews, spend trying to find the desired communication routines and paths within a company they have just joined?
- How much time do we spend reading communications that others are dealing with instead of getting on with our own work?
- How closely do we really keep abreast of current events in our business when we let the ad hoc appearance of information on our desk dictate to a large extent the subjects that gain our attention?
- How many times do we, or others in critical roles within our companies, make decisions without referring to necessary information, purely because it takes too long to find it?
- How much faith do we have in our organisation's ability to maintain and disseminate information such that it can be found by those who need it, when they need it, even when they are not aware of its existence in the first place?
- Are we afraid of losing key personnel (e.g. on board crews) because when they leave they take valuable knowledge with them and leave behind a state of confusion as to where things are?
- How realistic are we if we expect crews to be familiar with company procedures, on board machinery instructions, inventories, checklists, documentation requirements etc, if even the most dedicated, permanent company employees could be spending a long time on board trying to locate specific requirements within this morass of paperwork?

The above questions lead us to conclude that we can save a lot of time and confusion as well as arrive at better decision making by doing something about the way we **route, communicate, index, store and retrieve information** in shipping.

We searched the market for a suitable system, but as such a system did not exist, we decided to design and to commission the development of one, which was suitably named "ISM-Solutions" (or ISM-S). A software company was contracted ("Ulysses Marine Electronic Market Ltd") to develop the system and a number of its programmers/developers were relocated within our company so as to work alongside the "shipping" people. Although this on occasions was somewhat disruptive to the personnel of both companies, it nevertheless allowed the development of a practical and tried system.

In our efforts we were successful in obtaining the support and partial funding for this work by two development projects of the European Commission: TREVI Esprit EP23311, and IDES Telematics Applications Programme Task TR5.10.

ISM SOLUTIONS

Early in the summer of 1998 the basic development work was completed. The ISM audits for DOC and SMC were successfully and relatively painlessly passed with Lloyd's Register of Shipping just before the July deadline using the fully computerised system. In fact, we believe that this was the first time a shipping company passed its ISM audits using a fully computerised system.

The system works by having the ISM/ISO 9002 Manuals, all relevant forms, checklists and all other communications between ship and office in electronic form. The mode of communication between office and ship is by e-mail. However, if a ship does not yet have e-mail, or if the items of communication are not urgent, the system allows the sending of messages or data by floppy disk. Filing of all information (checklists and communications) is automated.

The real and necessary innovation of the system is that it is “task and role based”, i.e. depending on the user’s role (Master, Chief Officer, Superintendent, Operations Manager, etc) and depending on the task he is about to embark, he is presented with all the relevant information available to support him in performing that task. We have conveniently divided the support information into: (i) Manual References; (ii) Relevant Information; and (iii) Support Tools.

Screen 1 shows the “task tree” of the Chief Engineer and its links to Manual References. In this example, when the Chief Engineer selects the task “Maintain and Operate Ship’s Machinery and Equipment”, ISM-S provides him with a direct link, in this example, to five relevant sections in the company’s ISM manual. The Chief Engineer can then read these manual references (see Screen 2 for an example), annotate them electronically if he chooses with his personal notes, and even make suggestions for changes via e-mail to the Designated Person. Furthermore, the system allows linking to any relevant entries in any other manuals (such as for example SOPEP, VRP, key IMO resolutions, or even to corresponding entries in a second language ISM manual if the company has felt the need to translate its manuals for the benefit of non-English speaking crew). In the example shown on Screen 1, additional reference is made to a set of non-ISM manuals. In conclusion, the officers and crew can now be sure that essential information of direct relevance to a job they do is brought to their attention, and they no longer need to guess the relevance, or ask the Designated Person, or look for a translator, or do any other time consuming and confusing activity.

The user, having selected his task, and in addition to having a direct reference to manuals, also has access, from within the task he is working, to “Relevant Information”, which includes: any previously filled forms, communications, reminders, standing instructions etc, whether originating from the office or from within the ship. Screen 3 shows an example of incoming communications to the Chief Engineer’s task “Monitor Bunkering Operations”, here mostly from the Second Engineer, and being relevant to the current voyage.

From “Support Tools” the user also has immediate access to any “blank” forms and checklists he may have to fill in as part of the task he is undertaking. Once filled in, such documents can either be sent to the office by e-mail from within the ISM-S system, or can be filed in the ship’s electronic directory. Finally, the user has access to any software the company has provided to assist in performing the task in question, such as for example spreadsheets, electronic distance tables, payroll programs, a link to a digital camera, etc. As an example, Screen 4 shows the Support Tools linked to the Chief Engineer’s task “Maintain and Operate Ship’s Machinery and Equipment”.

Easy location and retrieval of historic information is made possible by a search facility which allows the user to filter records according to: vessel, voyage, form name, and dates of interest. This is a most useful facility for internal or external audits. Screen 5 shows an example of searching and retrieving all forms containing in their title the word "maintenance" for a given vessel and for a selected period of time.

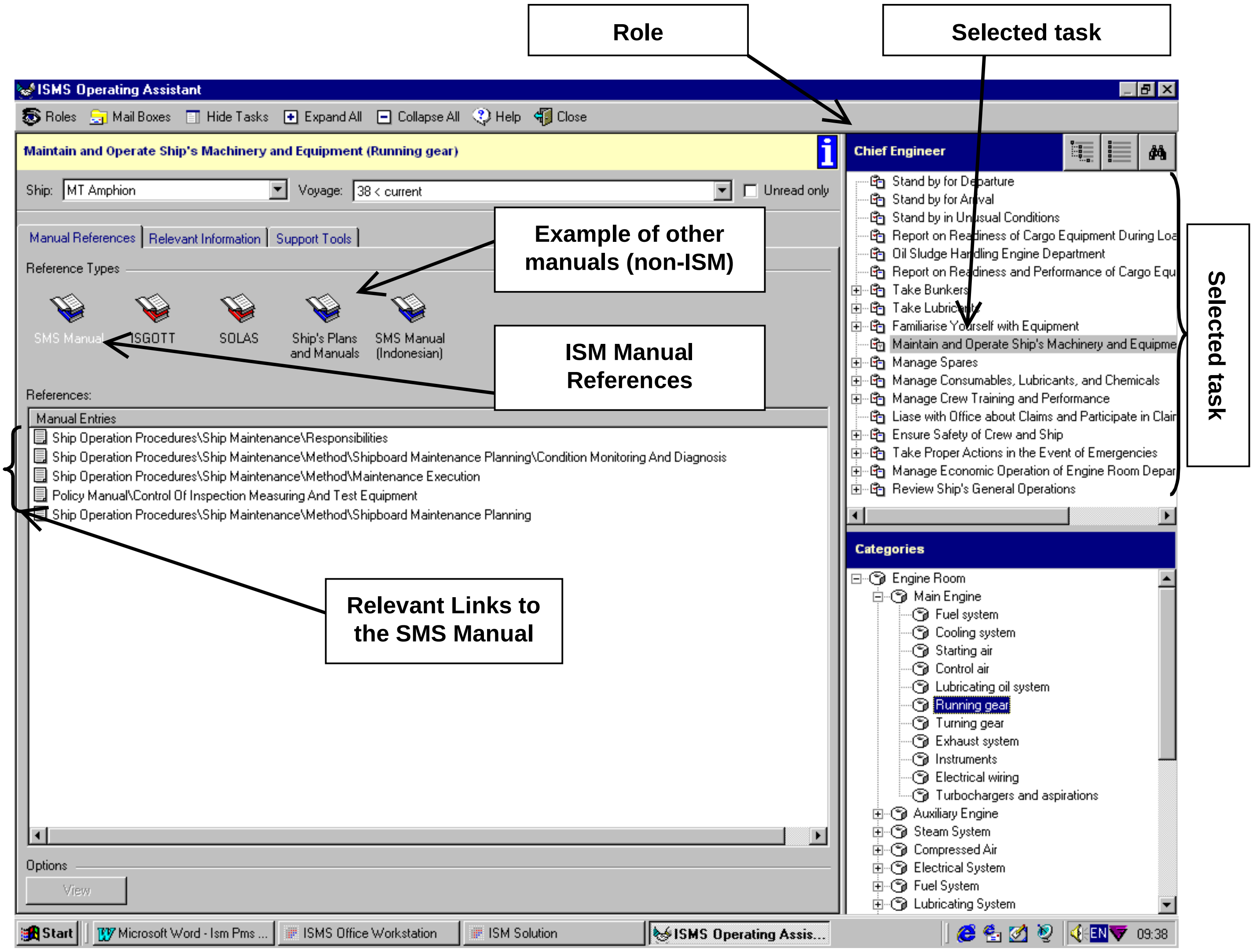
Manuals, forms, checklists, roles (i.e. personnel), tasks, and flow of information are all totally customisable, i.e. the system allows any company to populate and operate the ISM-Solutions software with their existing company structure and systems. Furthermore, if a company's organisational structure changes at some time in the future (for example a new role is created in the office and a redistribution of tasks takes place) the ISM-S system is simply modified in-house to model the new structure without loss of historical data. After the system has been used for a few months its value becomes more apparent because a company's recorded experience starts building up. Reminders, and records of past experiences effectively build into a "corporate memory".

IN CONCLUSION

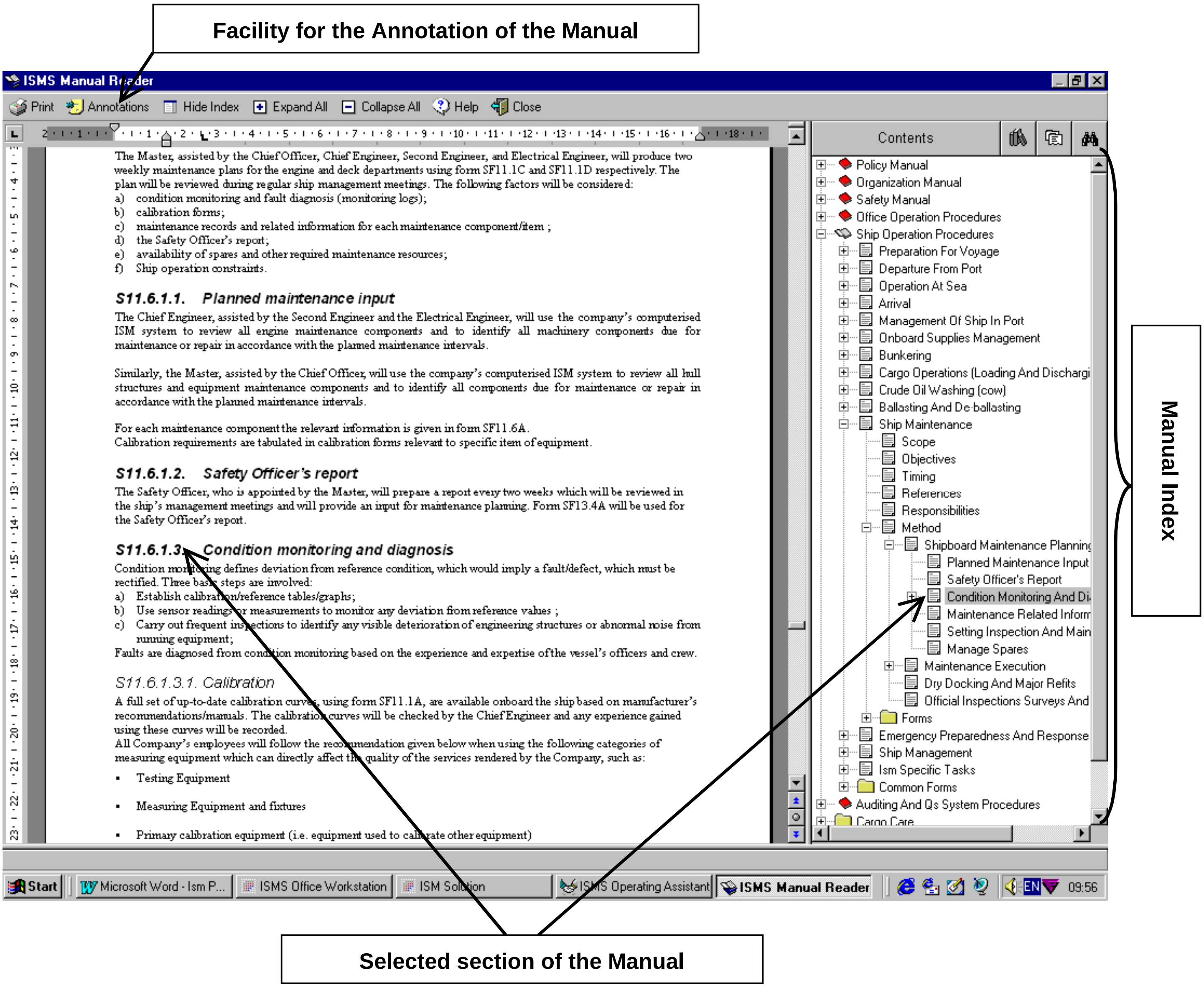
There is no hiding the fact that the ISM Code will cause maintenance problems to be brought to the attention of Owners, Auditors and Regulators. There is also no doubt that Legislation will increase the burden of documenting even more aspects of ship operation, e.g. ISO 14000 etc. Our philosophy is to fend-off the extra burden on the ship operator by using the new tools of technology to reduce confusion, to reduce the effort needed to locate proper information, and to simplify document control.

We believe that with ISM-Solutions we have created a practical tool which allows a company to record its experience and knowledge and to share it to relevant personnel on board and ashore. Any member of the company (whether seagoing or shore based) has access to any available information, for what he needs, when he needs it. Giving such effective access to information, which may otherwise lie unread in forgotten volumes, must be the key into the essence of the ISM Code.

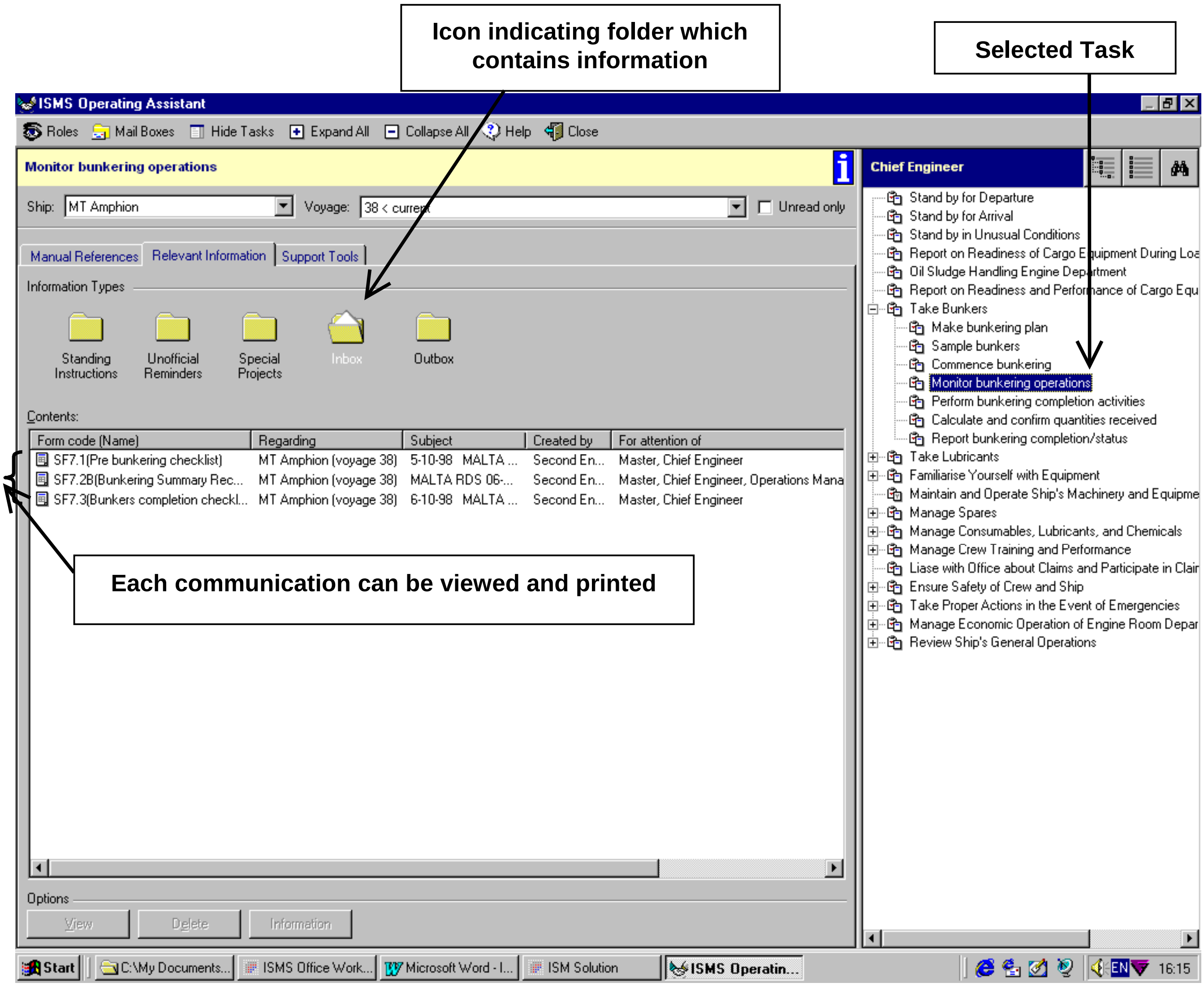
As mentioned earlier, a successful Planned Maintenance system needs a technically stable and predictable vessel, which means a vessel for which sufficient experience has been gained, and which has manageable outstanding maintenance and few undiagnosed problems. To achieve this, the owner must spend more time and money in the initial stages of operating a newly acquired vessel if he is to avoid related non-compliances. In any case, as indicated in this paper, the proposed organised proliferation of critical information will retain experience of on board occurrences and will reduce unnecessary deviations from the maintenance plan. With this in mind we find that it is appropriate to now extend our information dissemination software so as to fully address the real work flow of Planned Maintenance which must be based on a very close study of working methods in the company offices and of the ships, in order to improve time consuming processes and bring more useful information more easily to the user. Our philosophy is therefore to integrate Planned Maintenance in our ISM-S system, with instructions, forms and communications relevant to the full operation of the vessel so that there is no confusion as to where to find information relevant to any job on the vessel, whether this information is technical or operational. We do not expect to find some miraculous short cut to achieving predictable maintenance on vessels, but we will definitely eliminate the unnecessarily inadequate information flow to Chief Engineers and the inconvenience of presently designed computerised systems for Planned Maintenance.



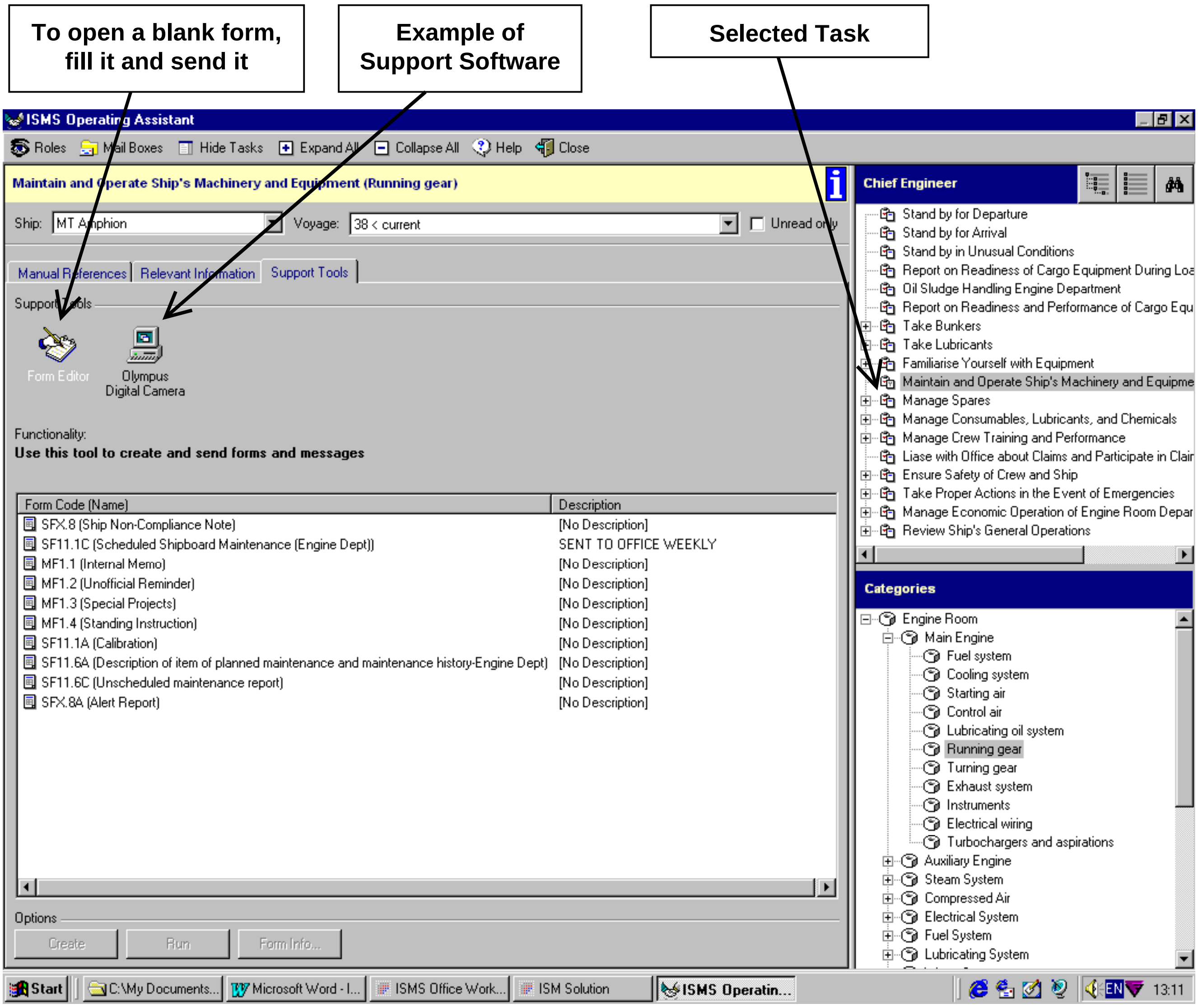
Screen 1: Example of a Role, its tasks and the links of a selected task to relevant sections of the Manual(s).



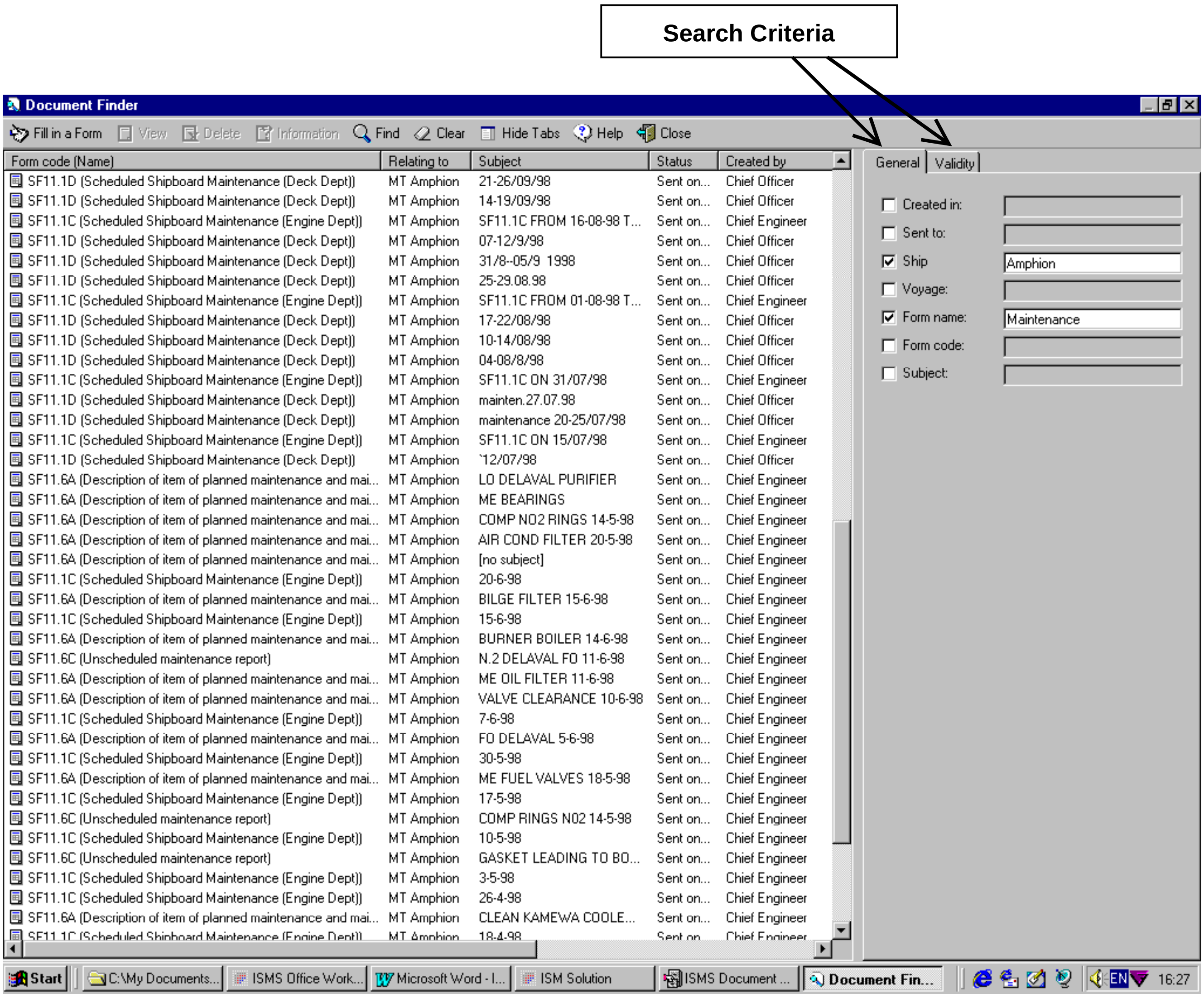
Screen 2: Manual Reader, showing one of the entries linked to the selected task of Screen 1.



SCREEN 3: EXAMPLE OF RELEVANT INFORMATION (COMMUNICATIONS, CHECKLISTS, INSTRUCTIONS) FOR THE SELECTED TASK AND VOYAGE.



SCREEN 4: EXAMPLE OF SUPPORT TOOLS LINKED TO THE SELECTED TASK (FORM EDITOR: FOR CREATING AND SENDING COMMUNICATIONS AND CHECKLISTS; OTHER RELEVANT SOFTWARE FOR ASSISTING IN CARRYING OUT THE SELECTED TASK).



Screen 5: Example of search and retrieval of forms by form name and by period.

