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COMMITTEE IV.2  
**DESIGN METHODS**

**COMMITTEE MANDATE**

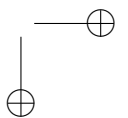
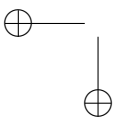
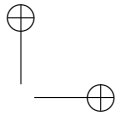
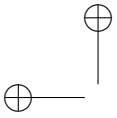
Concern for the synthesis of the overall design process for marine structures, and its integration with production, maintenance and repair. Particular attention shall be given to the roles and requirements of computer-based design and production, and to the utilization of information technology.

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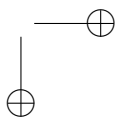
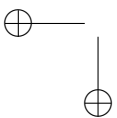
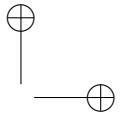
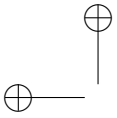
**REPLY BY COMMITTEE MEMBERS**

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**CONTENTS**

1	Discussion . . . . .	181
1.1	Official Discussion by Christian Cabos . . . . .	181
1.1.1	Introduction . . . . .	181
1.1.2	Section 1. Introduction . . . . .	181
1.1.3	Section 2. Design for Life Cycle . . . . .	182
1.1.4	Section 3. Available Design Methods . . . . .	183
1.1.5	Section 4. Available Modelling and Analysis tools . . . . .	183
1.1.6	Section 5. Optimisation and Decision Support Tools . . . . .	185
1.1.7	Section 6. Product Lifecycle Data Management . . . . .	185
1.1.8	Section 7. Obstacles, Challenges and Future Developments . . . . .	186
1.1.9	Section 8. Survey on IT Tools and Data Exchange . . . . .	187
1.1.10	Summary . . . . .	187
1.1.11	References . . . . .	187
1.2	Floor and Written Discussions . . . . .	188
1.2.1	Masanobu Toyoda . . . . .	188
1.2.2	Igor Ilnytskyi . . . . .	188
1.2.3	Adrian Constantinescu . . . . .	189
1.2.4	Ionel Chirica . . . . .	189
2	Reply by the Committee . . . . .	189
2.1	Reply to Official Discussion . . . . .	189
2.2	Reply to Floor and Written Discussions . . . . .	191
2.2.1	Masanobu Toyoda . . . . .	191
2.2.2	Igor Ilnytskyi . . . . .	191
2.2.3	Adrian Constantinescu . . . . .	191
2.2.4	Ionel Chirica . . . . .	191
2.3	Acknowledgement . . . . .	192



## 1 DISCUSSION

### 1.1 Official Discussion by Christian Cabos

#### 1.1.1 Introduction

The committee has made Lifecycle Management (LCM) the central focus of this report. This is a well justified move, as this methodology is slowly finding its way into the shipbuilding and shipping industries. It is evident that there is commercial benefit for a ship owner to not separately strive for a low price of the new-built ship and then later to optimize maintenance costs. Rather, the total cost over the lifetime of the vessel, i.e. the lifecycle cost (LCC) must be of concern. In this respect Lifecycle Data Management plays a central role. Referring to Marrall *et al.* (2011): “*The consistent use of information, data and knowledge along the entire life cycle can drastically increase production performance and the competitiveness of all actors along the chain.*” Since after the warranty period, the newbuilding shipyard typically has no commercial link to the delivered vessel, the ship owner has the task to make sure that the design of his vessel and the choice of systems and components installed on it will lead to an efficient operation over the lifetime. The situation is further complicated by the fact, that a significant part of the operational cost is not covered by the owner but charterer of the ship.

The reviewed report gives a comprehensive overview about methods and software which are today applied in ship design and which have a lifecycle focus. The conduction of a survey performed by the committee members gives the report a solid foundation, even if a higher number of respondents to the survey would have been helpful. This review will try to add additional information on Lifecycle Management and its connection to design methods where this is possible. A particular focus will be put on Lifecycle Management in ship operation as this is less covered in the report. Each section of this review will refer to a corresponding section in the report.

#### 1.1.2 Section 1. Introduction

The reviewed report gives a breakdown of the cost types making up Lifecycle Cost. In fact, there are numerous activities in the industry for reducing a single cost component in ship operation. Examples of these are given in section 2.1. Further examples can be added here, such as

- Services offered for energy optimization such as the Ship Energy Efficiency Management Plan (SEEMP), trim optimization or hull form optimization,
- Software for optimizing maintenance and repair,
- Procurement software for shipping companies,

which all contribute to reducing cost in a particular discipline. These are services and software aiding in ship operation directly. The market for such systems today is quite extensive and an overview on software supporting ship management and operation would be helpful and could be a mandate for a future committee report.

A publication covering such systems is e.g. Jahn (2011). Approximately 35 software providers today offer software for shipping companies, most of them covering only few of the relevant processes. Regarding fleet management –used here as the term for the comprehensive and integrated support for most of these processes through an integrated system– one must state that there is today a lack of such an integrated system.

Although the named software systems typically support the operational processes of a ship management company, they hardly follow the idea of lifecycle optimization

which would require data integration and long-term analysis capabilities based on the information stored in this integrated model. This model would encompass technical as well as cost information. Such functionality would be the target of an ILCM system as described in section 2.1 of the report. An ILCM would in particular integrate cost models from design *and* operation. As described in the report, PLM would be the methodology supporting knowledge acquisition with regard to performance and cost of the ship and its systems and components over the lifetime.

Although actual cost information is typically difficult to obtain, there is some published information available concerning e.g. the breakdown of the operating cost of container vessels, see HSH Nordbank (2009).

### 1.1.3 Section 2. Design for Life Cycle

Section 2 takes up the subject of design for lifecycle. An Integrated Lifecycle Management System would be the tool to support optimization for maximal benefit in terms of safety, low environmental impact and high profitability. The disciplines to be covered are well described in the report, additionally cargo handling and voyage management systems should be mentioned as systems supporting ship operation. The reason is that cargo history e.g. can give valuable information concerning loads acting on the vessel during its lifetime which again can be used for fatigue assessments. Voyage data is e.g. helpful for computing a vessel's efficiency with respect to environmental issues. Systematic evaluation of such lifecycle data could then feed back into design of future vessels.

Section 2.2 touches the important aspect of passing information between design and operation. Here the GBS are named which set standards for the exchange of required information for the maintenance of innovative ships. As mentioned, it will only apply to bulkers and double hull tankers. Obviously, the need for more detailed information from design is already apparent, as ship managers are today requesting software and associated models for maintenance procedures based on the actual condition of the hull and systems and components for all ship types. This need is particularly pronounced for floating offshore installations. There, the direct cost for towing the unit to a repair yard and also the connected loss of income due to downtime is often significantly higher than in shipping. Innovative maintenance schemes are therefore requested and developed e.g. for FPSOs. Consequently, transfer of building information from design to operation is performed more frequently for offshore units due to owners' requests.

The building yard's IPR concerns must be balanced with the request for more detailed information on vessel design to be used during the lifecycle. IMO discussions on the SCF will set standards here. Nevertheless, the level of information passed from design to operation does significantly depend on the negotiations performed between the ship owner and the yard during contract phase.

As reported in section 2.3, drivers for ILCM are cost savings such as energy efficiency measures and maintenance schemes. Apart from positive environmental and safety effects, condition based maintenance schemes typically have more direct cost saving consequences. For machinery equipment, they are in particular due to avoidance of unnecessary inspection and maintenance activities, to avoiding component breakdown and to avoiding damage due to unnecessary open-up inspections. In the case of hull maintenance, also repair preparation –both concerning time and scope– can benefit from better information derived from inspections.

Other drivers for LCM in the emission field are industrial initiatives such as the Clean Cargo Working Group (CCWG), which represents a significant part of world wide

container transport. The aim of this group is to make transparent the environmental impacts of global goods transportation through measuring, evaluating, and reporting. This helps ocean freight carriers to track and benchmark their performance and report it to their customers in a standard format. On the other hand, cargo owners (shippers) can review and compare carriers' environmental performance when reporting and making buying decisions.

An additional driver for LCM could be ship safety. E.g. capturing and tracing the status (expiration date, service letters, observed condition, ...) of onboard Safety Equipment such as Lifesaving Appliances will further help to ensure that this equipment is fit-for-purpose when it is needed.

#### *1.1.4 Section 3. Available Design Methods*

Section 3.3.3 refers to Design for Environment. With increasing awareness towards environmental issues the efficiency of design, maintenance and operational options with respect to e.g. CO<sub>2</sub> reduction have been examined in recent years. Although this is not directly a design method, it is a good example of taking the lifecycle impact into account for decisions on e.g. design/retrofit options. One such study is published in Appendix 4 of IMO (2009). It reports on the marginal abatement costs, i.e. the maximum achievable CO<sub>2</sub> reductions against estimated cost-effectiveness, for measures such as propulsion system upgrades, hull coating, main engine tuning, air lubrication, etc. It therefore helps to decide on technical measures from a lifecycle cost and performance perspective.

#### *1.1.5 Section 4. Available Modelling and Analysis tools*

This section summarises well available CAD and naval architectural packages. Clearly most vendors of such systems are following the path of integrating more analysis capabilities in their packages. Here figures about the actual application of these tools on yards and in design offices (such as market shares) would be interesting – but possibly difficult to acquire.

The typical strategy of CAD vendors is to offer some specific analysis capabilities integrated in their CAD package. Nevertheless, rather than investing too much in own analysis capabilities, interfaces to specialised analysis toolkits are the preferred development direction when aiming at higher coverage of analysis capabilities. Taking FE strength analysis as an example, vendors like NAPA and AVEVA have invested in functionality for either directly generating FE meshes or for preparing geometry output ready to be meshed by an FE-pre-processing package from another vendor.

Typically, the calculation of loads, the assessment of the FE strength analysis with the help of buckling, yield and fatigue codes, the dimensioning of the structure according to class rules is then left to specialised packages. In that sense, there is today no comprehensive CAD and analysis package covering all design aspects. Rather, the expectation is that the future development direction will be the manifestation of interfaces between such packages and the integration of software from different vendors. Currently, no standards appear to emerge for such interfaces but rather they are specific to the respective CAD and analysis tools.

With regard to future optimisation capability the expectation (and hope) is, that a central model held in a CAD package will hold all information necessary for such optimisation. An optimisation engine connected to the CAD tool would then control a number of external analysis codes. The challenges in developing such an integration of packages are still manifold. To name a few

1. The CAD model will require a significant amount of additional meta-information in order to pass this to the analysis packages. Examples are main dimensions of the vessel, design intent such as lifetime, loading, expected operational profiles, etc. If this information is not held in the CAD package but rather entered in the analysis software no automatic update of the analysis would be possible. CAD vendors work in this direction, but the multitude of analysis codes and lack of standardization in the sets of additional required analysis parameters makes this difficult.
2. The topology of the CAD model must be sufficient to allow for FE meshing. This in particular requires additional effort on the side of the person building up the CAD model. I.e., the training requirements for the CAD modelling staff is increasing significantly.
3. Analysis post-processing –and in particular rules for assessment– typically require a definite level of abstraction. E.g. finite element sizes and used element types must be in accordance with the assessment rules. Again training is necessary to allow proper application of analysis codes in an optimization run.
4. Volumetric CAD models (as opposed to surface models) add another level of complication, since FE analysis models typically require surface elements.

The result of this is that the maritime industry is still by far not in the situation that the required analysis capabilities can be controlled from a CAD package holding a model which covers all topology, geometry and required meta-information e.g. for optimising a structure with respect to seakeeping, fatigue strength, ultimate strength and also other disciplines from the Design-for-X catalogue. In particular, there are high additional requirements with respect to knowledge on the side of the person controlling such an optimisation as compared to the skills in CAD construction work expected today.

Since interfacing is a central topic in the above named strategy, a survey on current developments in this area (in particular any standardization efforts) would be an interesting subject of a future report.

The inventory of hazardous materials (IHM) is the subject of section 4.1.3. Although optimally already set-up with the delivery of the ship, the IHM could not be regarded as a design and analysis tool but rather a tool for supporting the operational phase of the ship. The name “green passport” should be omitted here, as it is not connected to the IHM. Another relevant development in this area is e.g. the CDX service offered by HP in the non-maritime field but which is carried over to the maritime industries.

The conduction of a survey to report on the state-of-the-art (as performed by this committee) is very helpful and it is a pity that not more companies replied to the call to answer the questionnaire. Results of the survey could be complemented by the results from a similar survey on Lifecycle Management in the maritime industries conducted in 2010 and reported in Cabos (2012). The result of the latter survey in shipbuilding was that adoption of PLM in shipbuilding is considered important to achieve higher competitiveness and is expected to promise a good Return On Invest (ROI). Commercial PLM solutions available today offer a lot of potential that is not exploited yet in shipbuilding because most companies are only in an early stage of adoption. The situation is different in the supplier industry where several of the equipment manufacturers belong to the early adopters of PDM and PLM technology.



*1.1.6 Section 5. Optimisation and Decision Support Tools*

Section 5 reports on current optimisation and decision support tools. This part of the report is very comprehensive and this review will not be able to significantly add to its content.

*1.1.7 Section 6. Product Lifecycle Data Management*

Section 6 has a focus on the technology applied in the design phase and on the question on how information can be transferred to the operations phase of the vessel. It would of course be very relevant to also report here on tools and techniques for Lifecycle Management after delivery of the ship and on how information from operations phase is fed back into the design phase of new vessels.

In recent years, LCM techniques have appeared in several technical disciplines of ship operation. Lifecycle Management can be interpreted as a method for increasing the benefits of information gathering through efficiently making it available. This is done by connecting the information in a multitude of ways. Information is put in context from different views: in the system context, the fleet context, the temporal context, etc.

In this way a number of approaches which are finding their way into shipping can be seen as being parts of a Lifecycle Management methodology. Some of these approaches which have come up in recent years are

1. Hull maintenance
2. Condition based maintenance of ship equipment / machinery parts
3. Emission reporting
4. Damage databases leading to information regarding component reliability

It has to be noted although, that there is currently no integrated data management solution available which would cover all the named approaches in a single environment. Thereby there is no emerging integrated Lifecycle Management platform available in shipping. One implication also is that there is no systematic flow of information from operation to ship design. Nevertheless, e.g. for specific components, the manufacturers use experience from maintenance to improve component design or to adapt recommended maintenance schemes.

Maintenance in shipping is today in most cases based on the Planned Maintenance scheme. This means that inspection and maintenance activities are derived from a fixed number of running hours or elapsed time since the last inspection. Since the date of the next inspection does not rely on previous inspection outcome, no systematic storage of past inspection results need to be accessed. For that reason, current Planned Maintenance Systems (PMS) do not allow for a storage of this information such that automatic evaluation (such as trending) of the results of past inspections become possible. Typical data held by such systems are descriptions of necessary inspection activities, lists of components to be inspected, inspection dates and inspection outcomes (which might be free text). There is typically no connection of the inspected components in a PMS to its representation in the PLM system from the building phase.

It is the ShipDEX initiative which partly aims at closing this gap (in one direction) through providing information on component maintenance procedures from design phase to the operation phase. There is currently no standard however, to pass maintenance information back to design.

In the case of hull maintenance, the first step of an efficient maintenance scheme is the passing of hull design information to the ship manager. As described in section 2.2 of the report, this is supported to some extent by the SCF required for bulk carriers and double hull tankers from 2016 onwards (although still mainly based on drawings). Currently hull information available in ship operation is limited to the drawings passed over to the ship manager by the yard. Additional information such as CAD models are only passed on in rare cases, in particular if this has been negotiated between yard and ship owner during contracting.

Similar to ShipDEX, a standard is emerging for passing on information on hull condition in the lifecycle. It is the OpenHCM format which is currently developed further by some classification societies, software manufacturers, and other stakeholders in hull maintenance, see also the ISSC report 2009 of committee IV.2 and OpenHCM (2012). Using OpenHCM, also hand-over of structural models from yard to ship manager could be standardized.

As can be seen from recent conference publications, the offshore industry is very active in promoting Integrity Management programs for their fixed and floating structures (in this case called Floating System Integrity Management, FSIM). Refer e.g. to Wisch *et al.* (2009) or other papers of that conference for data and document categories to be maintained over the lifetime of a floating structure for an effective Asset Integrity Management.

Subsection 6.2.3 reports on the results of the survey. This confirms that only in specific cases information is exchanged between design and operation today. Also, in many cases, native formats are being used. Shipbuilding STEP protocols are today hardly applied, at least in the European and Asian shipbuilding industries. This is different e.g. from the widespread use of STEP AP 214 in the automotive industry, so this standard might in future also find its way in to shipbuilding (as it is not specific to an industry).

XML formats are indeed increasingly being applied in the shipbuilding and shipping industries. Nevertheless, they should not be compared to a STEP standard, because the latter describes a data model, whereas XML is a format specification being able to hold data of any data model (with certain restrictions).

#### 1.1.8 Section 7. Obstacles, Challenges and Future Developments

The survey findings, namely that AutoCAD, Excel and Rhino are the design tools in use in most cases, shows that there are still a number of steps to go on the way to an integrated PLM model of the vessel. The reason is that these general purpose tools lack any common data model (with the exception of geometry) being able to represent a ship during its lifecycle.

As described before, the major obstacle is in particular, that there is no such standard Lifecycle data model. So even while there are initiatives in certain areas, such as ShipDEX or OpenHCM for data exchange in the lifecycle, there is e.g. currently not a widely agreed standard for classifying the components, systems and structural parts of a vessel. While European yards often apply the SFI classification scheme, Asian yards apply different schemes and these are in the most cases not carried over into the operations phase of the ship. Such a classification system would have to be implemented in a data model being able to describe the ship and its components over the lifetime.

Once such common classification schemes and data models implementing them become available, general purpose LCM tools could more easily be used to set up an integrated Lifecycle Management.

As mentioned in subsection 7.3, the automatic derivation of analysis models, in particular FE models, from CAD pose an obstacle to comprehensive optimisation in the design phase. For that reason current approaches focus on common parametrisation of the CAD and a semi-automatically generated FE model. Using these parameters, an optimisation can be performed. Although not giving the full flexibility, this seems to be a pragmatic approach which will be present for some years to come.

#### 1.1.9 Section 8. Survey on IT Tools and Data Exchange

Comments on the results of the survey have been given in the above sections.

#### 1.1.10 Summary

In the opinion of the reviewer, Lifecycle Management has rightly been chosen by the committee as the central subject of this report on design methods. Through interconnecting information (which might already be available today) future technology will help the industry to achieve cost benefits from a holistic, i.e. life cycle, perspective. The difficulty will lie in the changes of processes and procedures which are required to successfully apply such technology. For that reason, development and introduction of LCM as a methodology applied in the marine industry will accompany us for many years to come. Hopefully, future reports will report on its evolution.

Regarding today's situation, it would be helpful to gain more insight into the actual application of the reported technology on ship yards and also in the shipping industry. This was the intention of the survey, but due to the lower number of responses no clear picture yet emerges from it regarding a quantitative assessment of applied technologies. The situation is more difficult in shipping, since the survey did not cover ship management companies. A survey covering these stakeholders would be a valuable addition to a future report.

The committee has taken significant effort to report on the state-of-the art and future direction of design methods for marine structures. The reviewer would like to thank the members of the committee for successfully delivering this informative, very comprehensive and insightful document.

#### 1.1.11 References

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## 1.2 Floor and Written Discussions

### 1.2.1 Masanobu Toyoda

With regard to lifecycle management data during lifecycle of a ship, it is considered that monitoring data after delivery, such as wave height, ship's speed, hull girder stress and cargo weight distribution, will be more important in the near future.

For instance, there are many ships and they have different route from heavy weather route to calm weather route. And some operators need to sail through a harsh weather with higher speed in order to keep their timetable, or some operators have enough time to reroute or wait to avoid rough sea. So wave load history and resulting cumulative fatigue damage on each ship would be quite different, and UK MAIB report on *MSC NAPOLI* accident mentioned the large effect of sailing speed under harsh weather and the difficulty to know accurate weight of each container. Therefore, these monitoring data will be beneficial to maintenance, second hand value, safety operation and feedback to design and rules.

I would like to know your opinion about the monitoring data mentioned above.

### 1.2.2 Igor Ilnytskyi

My congratulations to chairman Mr. Jean-Yves Pradillon and all Committee members for the very interesting report.

My first comment to Section 3.3.5. Design for Retrofitting and Refurbishment regarding problem of making passenger vessels more flexible to changes in the market.

For new generation of river passenger cruise vessel just on concept design study we apply general arrangements with functionally divided vertical zones:

- passenger cabins – “Hotel” zone with similar modular cabins on each verticals;
- restaurant/entertainment and recreation zones

When necessary in design stages or during operation of the vessel to change level of comfort due to changes on cruise market in future (to reduce/increase area of standard passenger cabin with changes of passenger capacity):

- Standard passenger cabin areas may be varied (in our case from  $13 m^3$  to  $18 m^3$ ) depending on required level of comfort. Passenger capacity of the vessel is correspondingly varied without changes of cabin's (hotel) zone borders;
- Restaurant/recreation zone have also constant borders – increasing/decreasing capacity of restaurants, saloons etc. and changes by specific area per passenger corresponding to the level of comfort (furniture changes);
- Fire protection zones and main hull structures and systems not necessary to change.

My second comment is to the Section 4.2.4 Computational Fluid Dynamics design method in application to ship design.

We agree that CFD tools require highly specialised engineers and high computational power. Really most of design bureaus and shipyards are not equipped with appropriate computer platforms and have not the necessary skilled staff.

We will see the solution of the problem in cooperation with design bureaus which are specialised on CFD tools.

Our bureau has experience of works with a design bureau specialised on CFD tools to have results of this cooperation on a very early design stage (concept design).

Using CFD tools instead of tests in a Ship Model Basin will allow to reduce time and design costs.

### 1.2.3 *Adrian Constantinescu*

First of all, I congratulate the committee for the great work and also for the presentation. During the presentation, Mr. J.-Y. Pradillon talks about HCM which stands for Hull Condition Model. The HCM seems to become the base (main) language implemented in Condition Monitoring software. It will be interesting to present more these kinds of software, and maybe to try to select a common format data (common language) based maybe on HCM for all Condition Monitoring software. It will allow the exchange more easily the maintenance and repair data between actors.

### 1.2.4 *Ionel Chirica*

A lot of terrorist actions and accidents due to human errors took place in the last decade.

The effects of these actions are very huge damages, so from point of view of human losses and of ship structures, why not the specific organizations as class societies, ship design companies and other organization did not introduce in the design philosophy new certain methods or methodologies in this topic?

The results of these activities can be certain coefficients aimed to penalise the scantling selections, or certain special risk coefficients.

These activities can have an important impact on the future ship design philosophy.

## 2 REPLY BY THE COMMITTEE

First of all the Committee would like to thank all the ISSC members, who provided the Committee with official, floor and written discussions, for their very aware, wise and interesting comments. From our point of view this is a strong sign to demonstrate that ISSC is really relevant and a "place to be" for the ship structure experts of the world.

### 2.1 *Reply to Official Discussion*

The Committee would like to specially thank Dr. Cabos for his Official Discussion. It is not only a cross check between the mandate and the report contents. It is rather a comprehensive complement of the report that provides the reader with several valuable additions.

Dr. Cabos agrees the Committee's choice to make the Life Cycle Management the backbone of the report. He does insist on the key role the LCDM (Life Cycle Data Management) will have in the very next future for all the stakeholders of the ship industry. We are convinced that LCDM is a main challenge for ship design in the next decades. We also agree that the meaning of "ship" in that respect must be taken as usual in ISSC reports: All structures at sea - including offshore platforms dedicated to Oil & Gas industry or Marine Renewable Energies (MREs). The rules and control authorities may vary from one sector to another but the final goal is the same in all cases: Reducing OPEX (even with a higher initial CAPEX), minimizing impact on human life and environment and taking the sustainable growth into account. In that respect we do agree that all life cycle management data gathered from ship operation is of a critical importance to support the report. We thank Dr. Cabos for the

interesting references he provided the reader with in this specific area. The Committee experienced many obstacles to reach such data during the literature review, thus the data from Dr. Cabos is very welcome.

In the Committee's reply, we decided to select three main comments of Dr. Cabos regarding the ship operation:

- Regarding the need to assess and optimise hull form and trim together with ship performances, the Committee fully agrees and some ongoing projects deal with this topic at national and international funded levels in various countries.
- The need to get consistent data on real load conditions to help fatigue damage assessment is also acknowledged by the Committee.
  - Benefits from monitoring systems have already been highlighted in previous reports of this Committee.
  - MONITAS (International JIP project) is an example of an ongoing project
- The Committee agrees Dr. Cabos regarding his comments on relatively different way of undertaking LCM in shipping and offshore industries.
  - It is in turn very different with MRE and civil engineering at sea but with the same goal as already highlighted in this reply.

The Committee also would like to clarify what the Official Discusser tells regarding the difference between the Inventory of Hazardous Materials (IHM) and the Green Passport:

- Green Passport Inventory was the name of a recommendation in a resolution of IMO dated 2004,
- IHM is a requirement in the Hong-Kong Convention (HKC) adopted by IMO in 2009,
- IHM is analogue to his ancestor and is often referred as Green Passport,
- Officially, HKC entered in force mid 2010:
  - After having been ratified by 15 States,
  - Representing 40 per cent of world merchant shipping by gross tonnage.

Finally, the Committee would like to come back on three other comments from the Official Discusser review:

- STEP & XML
  - The STEP & XML standards were described so many times in previous TCIV.2 reports. The Committee found no significant advances to report.
  - Thus, the Committee decided to cover it only in pages 547-548 of the report.
- Reference to ShipDEX and OpenHCM
  - It is a very valuable comment: We recommend that this topic must be covered in the next TCIV.2 report.
- Not enough replies to the survey
  - The Committee regrets and also acknowledged so few replies.
  - Answers were difficult to get but are enough to show a consistent, even if incomplete, figure.

Once more the Committee would like to thank Dr. Cabos for his very valuable complement to the report. We do recommend the reader who wants to have a comprehensive view of the covered topics to supplement the reading of the report with the Official Discussion.

## 2.2 *Reply to Floor and Written Discussions*

### 2.2.1 *Masanobu Toyoda*

Dr. Masanobu Toyoda raises a very interesting point during the congress. He mentions the importance of various monitoring (and especially hull condition) to be installed on board on a systematic basis. This Comment is fully consistent with what the Official Discusser presents. The Committee fully agrees that this will help to get decision making tools for the crew to select the better route, a valuable data collection for maintenance purposes and critical information for retrofiting (i.e. conversion of a tanker into a FPSO). We also think that we will have to face the reluctance of the crews and owners to make such a valuable initiative a reality. From our point of view, the only way to get it in force is to let authorities (flags, IMO, ILLC, IACS...) to make it mandatory.

### 2.2.2 *Igor Ilnytskyi*

Mr. Igor Ilnytskyi provides a very interesting input on passenger ships dedicated to inland navigation. We agree that the two main differences with open seas passenger ships are:

- Rather different load conditions and then specific rules and associated hull design,
- A more versatile market leading to a specific way of design allowing latter changes several times during the product life,
  - Thank you for such an input which has not been covered in the report.

The Committee also thanks Mr. Ilnytskyi for underlining the present situation in using CFD tools. These tools need very experienced engineers to carry out reliable computations and the regular ship yards usually have not enough studies a year to justify a full time team in this area. This is the reason why many ship yards (all over the world as demonstrated by the survey) are still subcontracting such studies to specialized design offices. What the survey also demonstrated, when compared to a similar survey the Committee carried out for ISSC 2003, is that 10 or 15 years ago the ship yards also subcontracted the FEM analyses but conduct it internally nowadays. Do we have to expect the same progress for CFD? The question is raised.

### 2.2.3 *Adrian Constantinescu*

Dr. Adrian Constantinescu proposes the Committee to look HCM-based software more in details. It is a good idea to be included in the next report. As far as the new chairman of this Committee for ISSC 2015, Matthew Collette, is a member of this Committee for 2012, he will be the key person to get the link alive.

### 2.2.4 *Ionel Chirica*

Prof. Ionel Chirica wants to bear in mind of the Congress attendees that perils of the sea, especially terrorism acts, is not yet taken into account by ship designers for civilian ships and that the rules will probably change in the future to take it into account. The Committee fully agrees this comment. The rules continuously changed over the centuries to include new safety ratios to take into account better knowledge or new situations (switch from wood to iron, brittle fracture, buckling, fatigue analysis...). But it will be impossible to make the ratios larger and larger making ships to carry more steel than cargo. That the reason why, the Partial Safety Factors entered in force within the IACS members rules these last years. We are convinced that these new design criteria will be addressed in such an approach. The Committee would

like to thank Prof. Chirica for raising this topic that could be addressed in detail in a future report of the ISSC TC IV.1 "Design Criteria" as an addition to what was discussed in the ISSC Specialist Committee V.1 since 2009. These reports discussed design criteria to be applied to the damage assessment after accidental events as well as accidental limit states.

### ***2.3 Acknowledgement***

The Committee would like to thank all the attendees of the Congress in Rostock for their attention during the session and for all the interesting and informal discussions we had during the breaks. Finally, the Committee would like to thank all the people who made ISSC 2012 a success and especially the Chairman Prof. Fricke and the Secretary Prof. Bronsart.