



Maritime safety and the human factor

Final report of SÄSAM- Safety and human-machine interaction in waterborne transport

Claes Källström

SSPA Sweden
Göteborg

Maritime safety and the human factor

Final report of SÄSAM- Safety and human-machine interaction in waterborne transport

Claes Källström

SSPA Sweden AB
P O Box 24001
SE-400 22 Göteborg
Sweden
Telephone +46-31-772 9000
Telefax +46-31-772 9124
E-mail postmaster@sspa.se

www.sspa.se

Maritime safety and the human factor
Final report of SÄSAM- Safety and human-machine
interaction in waterborne transport

by

Claes Källström

SSPA Research Report No. 129, 2004

ISBN 91-86532-42-1

ISSN 0282-5805

Published and distributed by:

SSPA Sweden AB

P O Box 24001

SE-400 22 Göteborg, Sweden

Telephone +46-31-772 9000

Telefax +46-31-772 9124

E-mail postmaster@sspa.se

www.sspa.seT

PREFACE

This report is the final report of the Research Project “SÄSAM- Safety and human-machine interaction in waterborne transport”, funded by Swedish Agency for Innovation Systems (VINNOVA, No 2001-05518), Swedish Maritime Administration (Sjöfartsverket, No 01 02 080) and Swedish Mercantile Marine Foundation (Stiftelsen Sveriges Sjömanshus, No 125/01 § 11). SSPA’s internal project number was 2001 2628. The project was running between 2001-12-01 and 2004-06-30, and the total financial support was 4 591 000 SEK (about 0.5 million EUR).

The Project Consortium was:

- SSPA Sweden AB, Project Management
- Information Technology/Human-Computer Interaction, Uppsala University
- Kalmar Maritime Academy
- MSI Design AB

The Project Manager and the Project Consortium acknowledge the financial support from VINNOVA, Sjöfartsverket and Stiftelsen Sveriges Sjömanshus and a valuable co-operation with Claes Unge (VINNOVA), Per Ekberg (VINNOVA and Sjöfartsverket), and Sten Gattberg (Stiftelsen Sveriges Sjömmanshus). The strong support from many shipping companies and equipment suppliers during the SÄSAM project is also highly acknowledged. A special thank to the SÄSAM Reference Group for their interest and engagement in the project.

Göteborg, June 2004

Claes Källström
Project Manager

CONTENTS

1	Summary	5
1.1	<i>Purposes and goals</i>	5
1.2	<i>Integrated bridge design</i>	6
1.3	<i>Augmented reality</i>	7
1.4	<i>Ship manoeuvring margin index</i>	7
1.5	<i>MarMet</i>	7
1.6	<i>Attitudes towards safety related issues</i>	8
2	Sammanfattning på svenska	11
2.1	<i>Målsättning</i>	11
2.2	<i>Design av integrerade bryggor</i>	12
2.3	<i>Förstärkt verklighet</i>	12
2.4	<i>Manövermarginalindex</i>	13
2.5	<i>MarMet</i>	13
2.6	<i>Säkerhetsmedvetandet hos sjöbefäl</i>	14
3	Introduction	15
3.1	<i>Project Management</i>	15
3.2	<i>Dissemination of results and knowledge</i>	16
4	Work Package 1: Judgements and decisions within operators on High Speed Craft	17
4.1	<i>Introduction to WP1</i>	17
4.2	<i>Purpose of WP1</i>	18
4.3	<i>Results from the activities in WP1</i>	19
5	Work Package 2: Attitudes towards safety related issues amongst Swedish officers and cadets	23
5.1	<i>Introduction to WP2: Development of safety awareness amongst students participating in the Sandwich education programmes at Swedish maritime academies</i>	23

5.2	<i>Existing attitudes towards safety related issues amongst active Swedish officers</i>	24
5.3	<i>Work package development</i>	26
5.4	<i>Results of WP2</i>	27
6	Work Package 3: MarMet Human Factor based design process, methods and guidelines for marine systems	31
6.1	<i>Introduction to WP3</i>	31
6.2	<i>Initial development work under MMSäk</i>	31
6.3	<i>MarMet – A brief description</i>	34
6.4	<i>Demonstration projects in WP3</i>	41
6.5	<i>Spin Offs</i>	48
6.6	<i>FREJ and ATOMOS IV: First commercial application of the MarMet methodology</i>	48
6.7	<i>Summary comments of WP3</i>	49
7	Work Package 4: Integration of the information on the bridge	53
7.1	<i>Introduction to WP4</i>	53
7.2	<i>Integration of radar, AIS and ECDIS information</i>	53
7.3	<i>Development of a new method for evaluation of ship manoeuvring margin</i>	54
8	Conclusions	57
9	References	59
10	Appendix: Conference “Maritime Safety and the Human Factor”	61

1 SUMMARY

The Research Project “SÄSAM- Safety and human-machine interaction in waterborne transport”, funded by Swedish Agency for Innovation Systems (VINNOVA), Swedish Maritime Administration (Sjöfartsverket) and Swedish Mercantile Marine Foundation (Stiftelsen Sveriges Sjömanshus), started 2001-12-01 and was completed 2004-06-30. The total financial support was 4 591 000 SEK (about 0.5 million EUR). The Project Consortium was SSPA Sweden AB (Project Management), Information Technology/Human-Computer Interaction at Uppsala University, Kalmar Maritime Academy and MSI Design AB.

1.1 Purposes and goals

The purposes and goals of the project were:

- To describe the ship operator system from a judgement and decision making perspective based on a control model.
- To develop a method for identification and examination of the confidence that the operators of high speed craft have in their own judgements and decisions.
- To develop prototypes of systems on the bridge that can facilitate the judgement and decision making process, based on how the work tasks on the bridge are carried out in reality. Special design focus is on the integration at the human level, not on the technical level. The integration of information from radar, AIS (Automatic Identification System) and ECDIS (Electronic Chart Display and Information System) is studied.
- To investigate and evaluate in a simulator the use of the technique “augmented reality” for steering of ships.
- To develop a ship manoeuvring margin index for objective comparisons of different manoeuvring procedures in restricted fairways for use both in simulator and in real life.
- To develop and test MarMet, which is a tool for human factors and MTO (Man, Technology, Organisation) based design processes, methods and templates to be used for requirement specification, design development and

evaluation of man-machine communication in maritime systems and applications.

- To investigate the attitudes towards safety related issues amongst Swedish officers and cadets.

1.2 Integrated bridge design

One study discusses what knowledge professional designers and end-users contribute to the design process, respectively. A case study, where user representatives and user interface designers separately worked on a design task in order to reveal differences in their respective contributions to design, was carried out. The study analyses how the participants communicate in the different groups, and the disparity between their vocabularies related to their professions. The significance of a common vocabulary for the outcome of collaborative work is discussed.

A second study on integrated bridge design reports on an interview with a bridge designer. Work on a high-speed ship bridge is complex, dynamic, and often demands full concentration and directed attention. The officers interact with many technical devices and computer support systems. The dynamic system that the officers thus control does not only involve their own ship, but also surrounding vessels, and external environmental factors as wind, high seas, current, and fog. Important issues that are not given proper attention in design of new bridges are highlighted.

Two other studies were focused on interfaces for safe navigation. Based on both theory and practice, a lot of effort was put into the development of an integrated instrumentation. One study showed that it is possible to come up with rather different design solutions than the ones that exist today. Such design solutions should be based on how the work tasks on the bridge are carried out in reality, that is, the design should be based on integration at the human level, not on a technical level. Integration of information from radar, AIS (Automatic Identification System) and ECDIS (Electronic Chart Display and Information System) and the interaction with the operator were explored in a special study. These systems have a very central role on the ship. Its function and management is of greatest importance in order to achieve efficient, safe and good environmental conditions for humans, society and property. The integration of radar, AIS and ECDIS information and how to present the selected information is the main outcome.

1.3 Augmented reality

Augmented reality was investigated in a case study where some of the key findings from the maritime work analysis were transformed into practical design. The study suggests that the problem with divided attention related to simultaneous overview of surroundings, radar screen, and other displays, can decrease with an overlay on the windscreen including a path, shorelines, and other vessels. The suggested solution would allow the captain to survey radar information while simultaneously watching the surroundings. Three captains evaluated this so-called augmented reality in a simulator. All of them were positive to the fairway presentation. They agreed that it gives a good perception of how the current situation will develop in the near future, but they also had important opinions about how details in the augmented reality should be altered in order to meet their requirements.

The augmented reality environment was further developed, adjusting the system in accordance with the opinions from the captains in the first study. A radar system was added to the simulator, making possible a study of how the use the radar system would change when the augmented reality was presented to a new set of captains. As expected, the augmented reality changed the way the captains used the radar system. When introducing augmented reality, the amount of time spent looking towards the out-the-window-scene increased, indicating a change in focus of attention within the operators. This result demands much more attention in future research in order to achieve a real safety improvement.

1.4 Ship manoeuvring margin index

A new method for evaluation of ship manoeuvring margin was developed. By use of the index different manoeuvring procedures in a restricted fairway in a simulator or in real life can be compared in an objective way. The method is based on a weighted assessment of the ship's manoeuvring ability, fairway restrictions and impact from wind and currents. The method was tested by use of comprehensive computer simulations.

1.5 MarMet

MarMet, which is a tool for human factors and MTO (Man, Technology, Organisation) based design processes, methods and templates to be used for requirement specification, design development and evaluation of man-machine communication in maritime systems and applications, was developed. In addition a number of demonstration projects, demonstrating both singular methods and also the application of a complete MTO procedure within a larger context and on a larger scale, were carried out.

The prototype MarMet methodology contains procedures, guidelines, analysis techniques and templates for the evaluation of existing systems and environments (bridge, engine control room etc.) as a means of identifying potential or existing design problems. MarMet also provides procedures, guidelines templates etc. for use in the design development process of marine systems. MarMet represents in fact a fairly complete design and evaluation process as well as a systematic documentation system.

As part of the project two major demonstration projects were concluded. These involved applying MarMet as an evaluation tool for a stand alone radar system and an engine control room onboard an existing ship at sea.

1.6 Attitudes towards safety related issues

The attitude towards safety related issues was investigated by use of interviews and questionnaires. The goal was to find out how Swedish officers and cadets actually tackle these issues, how they prioritise them, and if their attitudes changes over time.

The following general conclusions were found:

- The image formed on the basis of the completed questionnaires is that there is a positive attitude towards safety with a good safety level within the companies concerned.
- A clear majority of the respondents shows a high motivation, interest and engagement for all issues that can be related to safety.
- The survey also shows that attitudes do not always lead to attitude-conformant behaviour. The majority of the respondents can identify clear shortcomings and defects in the safety organisation they are part of.
- A quarter of the respondents could not fully understand their own role in the organisation. The respondents experienced that accidents, near-misses and other safety deviations only where reported to a limited extent onboard.
- A quarter of the respondents experienced recurrent shortcomings in the hand-over procedures.
- A notable finding was that almost 50 % of the respondents considered their Safety Management Systems manuals, introduced as a result of the ISM-code, to be poor.

- Another notable finding was that there seems to be a culture of not always following the safety rules onboard. About ¾ of the respondents experienced that safety was set aside to a various extent at times. It is not clear how much that can be referred to trifling matters and what the reasons are. However, the high percentage motivates a deeper study on the subject.

The study showed that the questionnaire and the analysing methodology together comprises a tool useful for its purposes, thereby fulfilling the identified needs. It can be easily adapted to an individual company's particular needs or desires. With this tool the maritime educational system will now have the possibility to measure and study, in a more reliable way, changes in attitudes and factors influencing the students' safety consciousness.

2 SAMMANFATTNING PÅ SVENSKA

Forskningsprojektet "SÄSAM- Säkerhet och samspel människa-teknik inom sjöfarten", med finansiellt stöd från Verket för Innovationssystem (VINNOVA), Sjöfartsverket och Stiftelsen Sveriges Sjömanshus, startade 2001-12-01 och avslutades 2004-06-30. Den totala projektvolymen var 4591000 SEK. SSPA Sweden AB (Projektledning), Informationsteknologi/Människa-datorinteraktion vid Uppsala Universitet, Högskolan i Kalmar och MSI Design AB utgjorde projektkonsortiet.

2.1 Målsättning

Målsättningen med projektet var:

- Att baserat på en reglerteknisk modell beskriva bedömnings- och beslutsprocessen vid styrning av fartyg.
- Att utveckla en metod för identifiering och undersökning av tilliten som operatören av höghastighetsfartyg har till egna bedömningar och beslut.
- Att utveckla ett operatörsinterface för säker styrning av fartyg, där designen baseras på integrering på mänsklig snarare än teknisk nivå och med speciell fokus på integrering av information från radar, AIS (Automatic Identification System) och ECDIS (Electronic Chart Display and Information System).
- Att undersöka och utvärdera tekniken "förstärkt verklighet" vid styrning av fartyg i simulator.
- Att utveckla ett manövermarginalindex för att på ett objektivt sätt kunna jämföra olika manöverprocedurer i trånga farleder, både i simulator och i verkligheten.
- Att utveckla och testa MarMet, som är ett verktyg baserat på kunskaper om "human factor" och MTO (Man, Technology, Organisation), för användning inom kravspecifikationsframtagning, systemutveckling och utvärdering, t ex avseende bryggor, bryggssystem och maskinrumssystem.

- Att undersöka säkerhetsmedvetandet hos sjöbefäl, både aktiva och under utbildning.

2.2 Design av integrerade bryggor

I en fallstudie undersöktes på vilka sätt användare/operatörer och designers bidrog till utformningen av systemen. Studien beskriver hur operatörer och designers, var för sig, arbetade med en designuppgift för att visa på skillnader i deras bidrag till den slutliga designen. En viktig slutsats var att man skall komma överens om en gemensam vokabulär för att slutresultatet ska bli bra.

En andra studie beskriver hur en tillverkare av en integrerad brygga för höghastighetsfartyg arbetar. Att styra ett höghastighetsfartyg är ett komplext och dynamiskt arbete, som ofta kräver full koncentration och riktad uppmärksamhet. Befälet interagerar med många tekniska utrustningar och datorsystem. Det dynamiska system som ska kontrolleras omfattar inte bara det egna fartyget utan också andra fartyg och externa faktorer som vind, vågor, strömmar och begränsad sikt. Studien belyser viktiga designaspekter, som man normalt inte tar hänsyn till vid design av integrerade bryggor.

Ytterligare två studier var koncentrerade mot design för säker navigering. Med hjälp av både teori och praktik utvecklades en integrerad instrumentering med det egna fartyget och dess omgivning i fokus. En slutsats var att det är möjligt att utveckla lösningar som skiljer sig avsevärt från dagens system, men dessa lösningar bör baseras på hur arbetet på bryggan bedrivs i verkligheten, dvs. designen bör bygga på integrering på mänsklig snarare än teknisk nivå. Integrering av information från radar, AIS (Automatic Identification System) och ECDIS (Electronic Chart Display and Information System) och operatörsinteraktionen var fokus i en specialstudie. Dessa system spelar en central roll vid styrningen av fartyg och deras olika funktioner, och användningen av dessa, är av största betydelse för att uppnå en hög säkerhet. Integreringen av informationen från radar, AIS och ECDIS, och hur selekterad information ska presenteras för operatören, utgör huvudresultaten från denna studie.

2.3 Förstärkt verklighet

Tekniken ”förstärkt verklighet” vid styrning av fartyg undersöktes och testades i simulator. Studien visar att problemet med delad uppmärksamhet mellan visuell övervakning av omgivningen, radarövervakning och andra informationskällor, kan minskas om information som visas direkt på

fönsterrutan. Denna information omfattar t ex det egna fartygets bana, begränsningar i farleden och andra fartyg. Den föreslagna lösningen innebär att operatören samtidigt kan övervaka radarinformationen och visuellt bevaka omgivningen. Tre sjökaptener utvärderade ”förstärkt verklighet” i simulatormiljö. Alla tre var positiva till presentationen av farleden, men hade också förslag till förbättringar. Ytterligare simulatortester visade på ett förändrat arbetssätt. Mindre tid ägnades åt att använda radarsystemet och mer tid användes för att ”titta ut” med hjälp av den förstärkta verkligheten. Mycket utvecklingsarbete återstår innan tekniken ”förstärkt verklighet” kan användas och dessutom måste det ändrade arbetssättet analyseras i detalj för att en reell höjning av säkerheten ska uppnås.

2.4 Manövermarginalindex

Ett manövermarginalindex utvecklades inom projektet för att på ett objektivt sätt kunna jämföra olika manöverprocedurer i trånga farleder, både i simulator och i verkligheten. Metoden bygger på en viktad värdering av fartygets manöverkapacitet, farledsbegränsningar och påverkan från vind och strömmar. Metoden testades med hjälp av omfattande simuleringar.

2.5 MarMet

MarMet, som är ett verktyg baserat på kunskaper om ”human factor” och MTO (Man, Technology, Organisation) för användning inom kravspecifikationsframtagning, systemutveckling och utvärdering, t ex avseende bryggor, bryggssystem och maskinrumssystem, utvecklades och testades inom projektet.

MarMet-prototypen innehåller procedurer, riktlinjer, analystekniker och formulär för utvärdering av existerande system och miljöer, t ex brygga och maskinrum, för att identifiera potentiella eller existerande designproblem. I MarMet finns också procedurer, riktlinjer och formulär för användning i design- och utvecklingsprocessen av marina system. MarMet utgör en, i stort sett komplett, design- och utvärderingsprocess, liksom ett systematiskt dokumentationssystem.

Två större demonstrationsprojekt med MarMet genomfördes inom projektet. Det första var att använda MarMet som ett utvärderingsverktyg för ett radarsystem och det andra för ett maskinrumskontrollsystem.

2.6 Säkerhetsmedvetandet hos sjöbefäl

Säkerhetsmedvetandet hos sjöbefäl, både aktiva och under utbildning, undersöktes med hjälp av omfattande intervjuer och frågeformulär. Några av de generella slutsatserna från undersökningen är:

- En positiv attityd mot säkerhet och en god säkerhetsnivå inom det egna företaget utgör den huvudbild som förmedlas.
- En klar majoritet av svaren visar på hög motivation, intresse och engagemang för alla säkerhetsrelaterade faktorer.
- Undersökningen visar också på attityder som inte alltid leder till ett handlande som stämmer överens med säkerhetsreglerna. Majoriteten av de svarande identifierar tydliga brister och defekter i den säkerhetsorganisation som man själv är en del av.
- Ca en fjärdedel av de svarande kunde inte fullt ut förstå den egna rollen/ansvaret i organisationen. De upplevde att olyckor, incidenter och andra säkerhetsavvikelser rapporterades endast i begränsad utsträckning ombord.
- En fjärdedel av de svarande upplevde återkommande brister i överlämnande-proceduren.
- Ett anmärkningsvärt resultat var att nästan hälften av de svarande ansåg att den egna "Safety Management Systems" manualen var bristfällig.
- Det är också anmärkningsvärt att det verkar finnas en kultur att inte alltid följa säkerhetsreglerna ombord. Ca 3/4 av de svarande upplevde att säkerheten var åsidosatt i varierande utsträckning då och då. Det är oklart om hur mycket av detta som gäller småsaker och det är inte heller klarlagt vad de bakomliggande skälen är. Den höga siffran motiverar en fördjupad studie i detta ämne.

Studien visar att frågeformulären och analysmetoden tillsammans utgör ett användbart verktyg för denna typ av utredningar. Metoden kan lätt anpassas till enskilda företags speciella behov och önskemål. Med detta verktyg har sjöbefälsskolorna nu möjlighet att mäta och analysera, på ett mer realistiskt och objektivt sätt, attitydförändringar i elevernas säkerhetsmedvetande.

3 INTRODUCTION

The SÄSAM Project is a continuation of the research project “MMSäk-Human-machine interaction and safety aspects when controlling fast ships”, that was funded by the former Swedish Transport & Communication Research Board (KFB). See Källström (2000). A Reference List can be found in Chapter 9, where all SÄSAM papers and reports also are listed.

3.1 Project Management

The Project Consortium and Team was:

- SSPA Sweden AB
Claes Källström, Project Manager
Peter Grundevik
Erland Wilske
- Information Technology/Human-Computer Interaction, Uppsala University
Anders Jansson
Eva Olsson
Mikael Erlandsson
- Kalmar Maritime Academy
Christer Bergquist
Cecilia Brandel
- MSI Design AB
Eric Wagner

Seven Project Meetings took place in Göteborg, Uppsala, Kalmar and Mölle. A Reference Group was established for the project with representatives from ship owners, equipment suppliers, ship design companies, Swedish Maritime Administration, Swedish Sea Rescue Society, Chalmers University of Technology, and Swedish Mercantile Marine Foundation. Two Reference Group Meetings took place, one in Uppsala and one in Göteborg. The significant support from the Reference Group was highly appreciated in the SÄSAM Project.

3.2 Dissemination of results and knowledge

The following dissemination activities were carried out:

- Two Reference Group meetings were organized in Uppsala and Göteborg (see 3.1).
- The SÄSAM Project organized the Nordic/Baltic Conference on "Maritime Safety and the Human Factor" at Kalmar Maritime Academy, Kalmar, on May 18, 2004. About 70 experts from Sweden, Denmark, Finland, Estonia and Latvia participated. Results from the SÄSAM project were presented. See Appendix for Invitation and Program.
- Parts of the SÄSAM Project were presented at:
 - VINNOVA's Workshop on Maritime Safety, Landsort, October 15-16, 2002 (Claes Källström, SSPA Sweden).
 - Transportforum 2003, Linköping, January 8-9, 2003 (Peter Grundevik, SSPA Sweden).
 - Transportforum 2004, Linköping, January 14-15, 2004 (Christer Bergquist, Kalmar Maritime Academy).
- Eva Olsson, Uppsala University, presented the paper "The Windscreen as a Display for Navigational Information" at the Royal Institution of Naval Architects (RINA) Conference on "Human Factors in Ship Design and Operation", October 2-3, 2002, London, UK.
- Eva Olsson, Uppsala University, presented a Poster "Safer navigation at sea using augmented reality" at the 16th HCI Conference, September 2-6, 2002, London, UK.
- Mikael Erlandsson, Uppsala University, presented a paper "Augmented reality as a navigation aid for the manoeuvring of high-speed crafts", at the International Design Conference, Design 2004, Zagreb, Croatia, 2004.
- Eva Olsson's Doctor Thesis "Designing work support systems- for and with skilled users", Acta Universitatis Upsaliensis. *Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology* 983, 76 pp, Uppsala, 2004, was publicly examined at Uppsala University on June 4, 2004.

4 WORK PACKAGE 1: JUDGEMENTS AND DECISIONS WITHIN OPERATORS ON HIGH SPEED CRAFT

WP-leader: Information Technology/Human-Computer Interaction, Uppsala University

4.1 Introduction to WP1

The bridge has a central role on a ship. The design of the systems on the bridge, and the design of the interfaces to these systems, affects the interaction between the operators and the ship. If the goal is to design a good interaction, then this interaction must be based on knowledge about how humans can and will perform actions in such environments. Such knowledge can be divided into two parts. Firstly, knowledge about general cognitive functions and processes within humans, and secondly, domain specific knowledge among the operators about the specific working conditions that make up the constraints for a good design at every particular bridge. Both types of knowledge are important to consider in design of new systems on the bridge.

General knowledge about human information processing capacity tells us about how we should design new systems in terms of cognitive ergonomic aspects. Within this field of knowledge, it is quite easy to find principles for how to use colours on symbols that are easy to recognize and remember, the structure and organisation of menus in the interfaces to the systems in order to avoid unnecessary cognitive strain on working memory, as well as size on signs and symbols etc. This knowledge is possible to generalize beyond every single application domain and very often it is mediated by generalists in system development and system design. Within the framework of SÄSAM this knowledge is supplied by WP3.

The domain specific knowledge is much harder to get hold of and it has been proven in other contexts, that it is only through the active participation from end-users in the work on the system design that such knowledge can be appreciated and utilized. The reason for this is that this knowledge consists in situation- and context-specific strategies that are activated in particular work tasks only. Unlike the general knowledge mentioned above, these strategies cannot be mediated by system developers with interest in design, but with the help from end-users and operators of such systems. These groups are, of course, specialized in one application domain only.

The activities and tasks that have been carried out in WP1 within the framework of SÄSAM are all to be considered as belonging to the domain specific knowledge area.

In WP4 in the framework of SÄSAM, it is discussed how different systems can be developed, taking into consideration possibilities of new technology and innovations. In WP1, the point of departure has been the working tasks that the operators working on different kind of bridges have. The two working packages are complementary since the use of new technology demands cognizance of what use demands the new systems must face up to. Inversely, the interaction between the operators and the systems can only be used efficiently if the operators have gained knowledge about how to appreciate new technology.

In Fig. 1 below, there is a schematic description of how the two Work Packages complement each other.

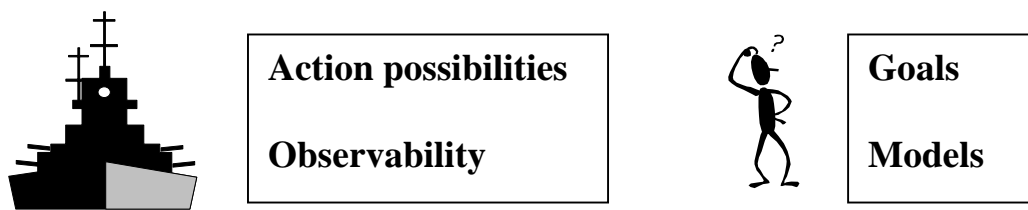


Fig. 1. The goals and the models (understanding) are properties of the human operator, whereas the action possibilities and the observability are properties of the technical systems. In the interaction with the decision support system, the operator is dependent on information from different input- and output systems. The action possibilities of the input systems, and the observability of the output systems are properties that affect how the operators can develop good mental models of how the systems work, as well as how general goals can be realized into more low-level goals and actions.

4.2 Purpose of WP1

The overall purpose of WP1 was to describe the operator system from a judgement and decision making perspective. The point of departure for this description was the control model that has been adopted as a general tool for such descriptions in other contexts. A second purpose was to develop a method for identification and examination of the confidence that the operators of High Speed Craft have in their own judgements and decisions. A fi-

nal purpose was to develop early prototypes of two different systems on the bridge that we think can facilitate the judgement and decision making process within the operators on the bridge.

4.3 Results from the activities in WP1

Parts of the results discussed below are found in the PhD Thesis “Designing work support systems- for and with skilled users”, Olsson (2004a).

4.3.1 Studies in the laboratory

4.3.1.1 *Integrated bridge design*

Olsson (2004b) discusses what knowledge professional designers and end-users contribute to the design process, respectively. The paper describes a case study where user representatives and user interface designers separately worked on a design task in order to reveal differences in their respective contributions to design. The design task was based on design sketches that had been developed in the work with captains on high-speed ferries. The paper analyses how the participants communicate in the different groups, and the disparity between their vocabularies related to their professions. The significance of a common vocabulary for the outcome of collaborative work is discussed.

Olsson (2004c) reports on an interview with a bridge designer. Work on a high-speed ship bridge is complex, dynamic, and often demands full concentration and directed attention. The officers interact with many technical devices and computer support systems. The dynamic system that the officers thus control does not only involve their own ship, but also surrounding vessels, and external environmental factors as wind, high seas, current, and fog. Officers need to anticipate precautionary actions that may be required or perform rapid judgements and actions, e.g. to carry out an evasive manoeuvre, depending on how a situation develops. The consequences of inattention can be fatal if the ship is in the wrong place or a ship on collision course is detected. The designer’s description of a case involving design of a high-speed bridge and subsequent conclusions on bridge design are presented in the paper. Important issues that are not given proper attention in design of new bridges are highlighted.

In Barchéus (2002) an interface for safe navigation of high-speed craft was developed. Based on both theory and practice, a lot of effort was put into the development of an integrated instrumentation consisting of two parts: one part that showed the ship’s relations to other objects in the surrounding world, and one part that showed important features on the ship as a system.

This study showed that it is possible to come up with rather different design solutions than the ones that exist today. Such design solutions should be based on how the work tasks on the bridge are carried out in reality, that is, the design should be based on integration at the human level, not on a technical level.

4.3.1.2 *Augmented reality*

Olsson, Seipel & Jansson (2002) and Olsson, Seipel, Jansson & Sandblad (2002) describe a case study where some of the key findings from the maritime work analysis described in Olsson & Jansson (2004), were transformed into practical design. The paper suggests that the problem with divided attention related to simultaneous overview of surroundings, radar screen, and other displays, can decrease with an overlay on the windscreen including a path, shorelines, and other vessels. The suggested solution would allow the captain to survey radar information while simultaneously watching the surroundings. Three captains evaluated this so-called augmented reality in a simulator. All of them were positive to the fairway presentation; they agreed that it gives a good perception of how the current situation will develop in the near future. However, they also had a lot of important opinions about how details in the augmented reality should be altered in order to meet their requirements.

Erlandsson & Jansson (2004) continued to develop the augmented reality environment, adjusting the system in accordance with the opinions from the captains in the study by Olsson, Seipel & Jansson (2002). Further, they also took measures on whether or not the new decision support system could be expected to alter the way the operators perceived the surroundings. To make this possible, a radar system was added to the simulator, making possible a study of how the use of the radar system would change when the augmented reality was presented to a new set of captains. As expected, the augmented reality changed the way the captains used the radar system. When introducing augmented reality, the amount of time spent looking towards the out-the-window-scene increased, indicating a change in focus of attention within the operators. This result demands much more attention in future research. All kinds of technologies that will affect how frequently the operators will use the radar equipment, must be developed with precaution.

4.3.2 **Field studies**

4.3.2.1 *Adaptation of the control model*

The field studies conducted between January and May 2004 are presently being analysed. A set of different methods are used in order to reveal as much as possible from these studies. The analyses are supposed to cover a

wide area of problems and issues, including a new model for describing decisions and judgements in naturalistic environments and the importance of system contexts for the development of mental models. The results of these analyses will be published in Jansson, Barcheus & Erlandsson (2004). In this paper, a comparison will be made between different driver environments, including captains of high-speed ferries, train drivers, as well as traffic pilots.

4.3.2.2 *Mental models within the operators: the importance of the task*

Olsson & Jansson (2004) is a study that contains a work analysis of captains on high-speed craft. The purpose was to describe the present conditions for officers that perform their work on high-speed bridges, supported by highly sophisticated technical systems that support manoeuvring and navigation. A control engineering approach was used while analysing the interviews with the captains and the officers. In the paper, the conclusion is made that the four general preconditions required for control of any system according to control theory are too broad, and therefore they need to be decomposed further in order to provide a correct representation of all the conditions revealed in the interviews. From the findings, it is also clear that the way which information is integrated and conveyed to the officers is inappropriate.

5 WORK PACKAGE 2: ATTITUDES TOWARDS SAFETY RELATED ISSUES AMONGST SWEDISH OFFICERS AND CADETS

WP-leader: Kalmar Maritime Academy

5.1 Introduction to WP2: Development of safety awareness amongst students participating in the Sandwich education programmes at Swedish maritime academies

Education and training of deck and engine officers for the Swedish merchant fleet has in modern times had a focus on development of a high safety consciousness amongst the students both on the nautical and the technical programmes. Safety awareness constitutes an integrated part of several of the course curriculum for both categories and is seen as an important element in many of the different areas of their studies.

It has, however, been difficult and even considered impossible to follow up on how these high ambitions actually have been transferred into practice by the students, even though all involved parties agree fully that the right attitudes and awareness in these matters are of outmost importance for the individual officers' possibilities to fulfil his work assignments. There is, of course, an official system within the academy where credits are registered in relation to performance, but how these theoretical results are put into practice has not been possible to measure in a reliable way.

The modern Swedish educational system, leading to a B. Sc. either in Nautical Studies or Marine Engineering, consists of a sandwich education with both theoretical studies at the academy and practice periods onboard various merchant vessels. This gives a situation where the students meet both teachers and lecturers at the academy and instructors and active officers onboard the vessels during the education. The study aims to investigate which of these two separate elements has the greatest influences on their attitudes towards safety related issues and also to identify possible shortcomings in the system, if any, and if they exist how these can be corrected and the system thus improved.

It would thus be of great value for the sandwich education system, as a whole, if an instrument could be formed which could assist in measuring

students' attitudes over time, showing how the system could be improved in way of guaranteeing that the students has the right attitudes and safety consciousness when they leave the academy to take up an active career as officers.

The study had the ambition to try to create such an instrument, in form of a questionnaire. A successful instrument of this type would also be of value when developing and forming the contents of courses for further training of active officers.

In addition, a need to describe the present situation amongst active officers was identified, where a number of questions described in more details below, were raised. This part of the project was aiming at finding out, in as much detail as deemed necessary, the present status in order to identify needs for improvements of the present safety systems. Perhaps most important were the part studies aiming at identifying what kind of training that should or could be added for active officers to enable the educational system to adapt accordingly.

5.2 Existing attitudes towards safety related issues amongst active Swedish officers

There were a number of questions related to this area where a need to investigate and deepen existing knowledge was identified. Until now no study was done to investigate how active Swedish seafarers actually tackle these issues, how they prioritise them, and if their attitudes changes over time.

Questions to which the investigation wanted to get answers were amongst others:

- What happens with the attitudes developed during their studies when the students have completed their studies, taken their degrees, and started working as active officers?
- What support do the officers feel that they have got in developing a sound safety consciousness from their theoretical studies at the academy?
- Have they identified any shortcomings, and if so, could they give suggestions for improvements either to the basic studies or through some kind of post-exam education, given at some later stage of their careers?

- How do they develop their safety consciousness over time and is there a positive or a negative development?
- Are there differences in way of safety consciousness between officers with longer experience and officers who recently left the academies?
- Are there differences between deck and engine officers?
- What influences their way of thinking and developing these attitudes?
- Do they feel that they have been successful with their work in safety related matters onboard and in their roles in the safety organisations?
- What support do they feel that they get from the shore based organisation for which they are working?
- Do they feel that they get the support they expect from the authorities in these matters?
- Do they feel that the ISM-code has improved the situation? If so, in what way?
- How is the reporting of incidents, near-misses and similar situations done in the company they work for?
- Do they feel that the ISM-manuals have been of assistance, when it comes to raising of the safety consciousness onboard their vessel?

Early in the study it was realized that many of the questions relating to both categories of officers and students were closely connected and that a common questionnaire could be used, with exclusion of some of the more detailed questions when used for students of the lower grades, yet lacking enough background experience and knowledge.

Another important ambition of the project was to create and develop the questionnaire in such a way that any ship owner and/or manager could use the same questionnaire to conduct an internal study of the situation in a particular company either by themselves or with the assistance of the academy.

5.3 Work package development

In order to formulate the questionnaire in such a way that the results would be possible to analyse by using recognized and accepted techniques and to be possible to replicate without influencing the result, a lot of efforts were put into the development.

The first stage of this process was accomplished by using a set of questions drafted in line with the initial project formulation towards several groups of active officers attending various courses and training sessions at the academy during the early spring of 2002 and towards students having a seagoing experience (questionnaire version 1).

After analyses of the results of these questions, some basic assumptions were drawn on how a questionnaire best would be worded. In order to validate these assumptions a number of deeper interviews with selected students were performed during the later part of the academy's spring semester.

During the autumn of 2002, these interviews were compiled and a new more extensive questionnaire was formulated. This questionnaire, version 2, was then used during the spring 2003 towards the same type of active officers as for the first version, but also towards the same students who took part in the first survey the year earlier.

During the same period contacts were established with ship owners and ship managers willing to participate in the survey. With the material thus compiled a final questionnaire, version 3, could be formulated. At the same time the academy had started cooperation with the Department of design sciences, ergonomics and aerosol technology, Lund Institute of Technology, which has previous experiences by performing similar studies within the aviation industry. The final format of the questionnaire was thus formulated in cooperation together with representatives from this department.

The questionnaire was composed of seven different areas and it was estimated that, on average it would take 1 – 2 hours to complete. General breakdown of categories are as follows:

- Background factors
- Onboard environment
- Experienced safety culture
- Personal prerequisites
- Motivation
- Social interaction
- Results of non-conformant safety related behaviour

During August 2003 the final version of the questionnaire was used towards all new students starting their studies at the academy on the sandwich programme, with the ambition to follow them during their studies and follow up with questionnaires pinpointing their attitudes towards safety related issues at regular intervals, after each session at the academy and after each training period onboard vessels. No analysis of the results has been made but cross-tabs and T-tests have been conducted. A full analysis will however be done at a later stage when comparable answers have been received.

During the autumn 2003 the questionnaire, version 3, was sent out to all shipping and management companies personnel departments for distribution out to the vessels, by which ever means they had at their disposal, regular mail, fax, e-mail etc.

Answers were received during the period October through to mid-December 2003 and analysis of the replies was carried out during the spring of 2004. Out of the 25 companies, which originally claimed that they were positive to participate, answers were received only from vessels belonging to 9 of them. All replies were, of course, treated with full anonymity.

The full description of this Work Package is given in Bergquist, Brandel & Åsenholm (2004) (in Swedish).

5.4 Results of WP2

In this summary of WP2 the results shown will only be the general conclusions that can be drawn from the survey. The full version, in Swedish, can be found in Bergquist, Brandel & Åsenholm (2004).

General results:

- The image formed on the basis of the completed questionnaires is that there is a positive attitude towards safety with a good safety level within the companies concerned.
- A clear majority of the respondents shows a high motivation, interest and engagement for all issues that can be related to safety. The attitudes shown in the replies amongst the majority of the population can be classified as safety-conformant. But the survey also shows that attitudes do not always lead to attitude-conformant behaviour. The acts by the respondents are, at times, contradictory to the attitudes shown in their replies.

- One notable finding was that it seems to be clear that the majority of the respondents are working in a safety environment where deviation from safety regulations is accepted at times.
- The safety organisation is perceived by the majority of the respondents as good. Even though, the majority of the respondents can identify clear shortcomings and defects in the safety organisation they are part of.
- Some of the organisations have obviously problems related to the understanding of the respondents' own role in the organisation. As many as about 1/4 of the respondents could not fully understand their own role in the organisation.
- The respondents experienced that accidents, near-misses and other safety deviations only were reported to a limited extent onboard.
- A quarter of the respondents experienced recurrent shortcomings in the hand-over procedures.
- A notable finding was that almost half of the respondents considered their Safety Management System manuals, introduced as a result of the ISM-code, to be poor, a finding that can be directly correlated to the three above mentioned safety factors.
- Another notable finding was that there seems to be a culture of not always following the safety rules onboard, as many as about 3/4 of the respondents experienced that safety was set aside to a various extent at times. It is not clear how much that can be referred to trifling matters and what the reasons are. However, the high percentage motivates a deeper study on the subject.
- Even though a majority of the respondents considered themselves to have a higher engagement in safety related matters than their colleagues onboard a majority of them, about 3/4, answered that they themselves set aside safety at times.
- The cooperation with their colleagues onboard was classified as good. Some stereotypic attitudes could be identified amongst the respondents, primarily connected to conception of safety awareness amongst seafarers of other nationalities.
- The respondents personal disregard for safety rules followed the same pattern as the existing culture of not always following them. There was no evidence of negative social influences or open or hidden threats for reprisals. No evidence either of the existence of a

“Blame-Free Culture” onboard or within the safety organisation could be identified. The internal or external social influences were regarded by a majority of the respondents as positive or very positive. The most influencing factor in this respect was the colleagues onboard.

- The majority considered their own abilities to be good or very good in relation to what was required from them by their work descriptions or assignments. Even though, a majority considered themselves in need of some kind of competence development and additional training. Almost 90 % answered that they could access additional training through their company’s internal training programmes. However, as many as 3/4 of the respondents claimed that they in addition to this needed to get access of further training within their professional scope and 64 % claimed a need to deepen their theoretical knowledge through other sources..
- The majority of the respondents were able to identify their own shortcomings and lack of ability. There was, however, a minority who did not have this insight and thus can be seen as a potential safety risk both for themselves and for their colleagues.

The study showed that the questionnaire and the analysing methodology together comprise a tool useful for its purposes, thereby fulfilling the identified needs. The tool can be easily adapted to an individual company’s particular needs or desire. With this tool the maritime educational system now has the possibility to measure and study, in a more reliable way, changes in attitudes and factors influencing the students’ safety consciousness.

6 WORK PACKAGE 3: MARMET HUMAN FACTOR BASED DESIGN PROCESS, METHODS AND GUIDELINES FOR MARINE SYSTEMS

WP-leader: MSI Design AB

6.1 Introduction to WP3

This Chapter summarises the final results of WP3, also given in Wagner (2004). This work package involved the development of human factors based methods, design and evaluation processes and guidelines for the design and/or evaluation of marine systems. At this point in time WP3 has been successfully completed with most goals being met and within budgetary constraints. In addition a number of demonstration projects, demonstrating both singular methods and also the application of a complete MTO (man, technology, organisation) procedure within a larger context and on a larger scale, have been carried out.

It should be noted that WP3 began under the auspices of the previous MMSäk project (Källström (2000)), but was only partially completed due to the lack of funding at that time. As a result of the situation, work with developing the MarMet methodology into a complete prototype was postponed or rather carried over into SÄSAM. As a result of this there was a gap in the further development of MarMet from the initial project. It may be pertinent to provide a brief summary of the results from the previous project MMSäk – a form of recap. See also Wagner (2000).

6.2 Initial development work under MMSäk

6.2.1 Developing MarMet – Working Phases

The initial start of the development of MarMet involved two phases. The first phase involved context mapping of the HSC bridge environment. The

second phase involved examining contemporary design processes as a starting point for the development of the MarMet methods toolkit.

6.2.2 Orientation and domain mapping – The first phase

During the initial MMSäk project, the context mapping activity involved the domain mapping of High Speed Craft (HSC) bridge environments in order to obtain a more comprehensive familiarity with and understanding of the HSC's shipboard operations, routines and bridge equipment and systems. Several field studies were carried out onboard HSC and also on one conventional Ro-Ro ferry for the purposes of general comparison. The process involved informal interviews and discussions with deck and engineering crewmembers coupled with observations of the bridge layout and physical equipment.

As the initial MMSäk project was initially directed towards high speed vessels, it was only natural that the development of MarMet also followed suit. However, based upon further discussions with interested parties and within the consortium, it was decided to adopt a more generic approach to the development of MarMet enabling the application of the MarMet methods toolkit to any type of vessel.

6.2.3 Developing the MarMet methodology – The second phase

The development of MarMet was interrupted for a period of time between the MMSäk project's completion and the start of the SÄSAM project. However, funding was made available enabling the SÄSAM project. This entailed that the initial inaugural efforts at developing MarMet could be resumed. Prior to this interruption, the first module of the methodology (project initiation) and a portion of the second module (context mapping) had been developed.

This second phase of WP3, the development of MarMet itself, involved identifying and gathering the various international marine standards (i.e. ISO, IMO etc.), classification society guidelines and other pertinent material which would have to be considered and incorporated into a methodology toolkit. In addition information regarding and MMI standards concerning shore based industrial MMI (Man – Machine Interaction) and control room standards were collected. This was deemed of interest as in some cases the shore based MMI guidelines might be somewhat more developed than in the maritime sector. With the SÄSAM project work was resumed at that point where we had left off.

The third activity involved examining various design process models, both in the form of developing international standards and also in the form of design process descriptions developed individually in the private and academic sector. Here there are a number of inspirational sources upon which we based the MarMet design process. There is for example ISO/DIS 13407 “Human Centred Design Processes For Interactive systems”, the “TRUMP process maturity model”, Human Factors guidelines For The Design Of Computer Based Systems “ developed by Loughborough University and of course ISO 9000. The main conclusion arrived at is that there are only so many ways a design process can be structured if it is to be commercially and practically viable and also conform to standards. It is interesting to note that design processes have been represented for example as iterative circular loops. Regardless of the representation the design process remains a time line based process.

The fourth activity required looking into the design model. This entailed identifying those design elements that will comprise an MTO based methodology. As the linchpin in the design model we have applied the standard ISO 6385 - “Ergonomic Principles for the Design of Work Systems”. It serves well as a general definition of a work system and it’s constituent components. These may be summarised as the physical work environment including not only equipment, instrumentation and controls but also factors such as vibration, ventilation, climate etc. Then there are the work processes involved including tasks and procedures, information flows, inputs an outputs etc. which also must be included in some manner.

The fifth activity involved the integration of human factors theories and concepts into the basic design model (the design components). We have also integrated the approaches of i.e. Jens Rasmussen concerning man – machine interaction, James Reason’s work concerning human error, and Donders reaction time models. Then there are the classical handbooks and other publications concerning human factors such as McCormick, Ivergård, Kirwan and Ainsworth, which can be integrated into the more specific guidelines.

The sixth project activity completed under the auspices of the SÄSAM project resulted in detailing the remaining MarMet templates according to the process and design model. In concrete terms the prototype Version 1.0 ”MarMet Design Process & Templates For Marine Applications” has been successfully developed. The templates have been produced using the Framemaker 5.5 program as it permits flexibility in modifying the templates and handles graphics quite well. In addition it permits an easy to use PDF exporting function which could be advantageous in inter-organisational communications using different platforms

In addition WP3 has embodied a number of smaller and two larger demonstration projects within a real life environment.

6.3 MarMet – A brief description

The prototype MarMet methodology contains procedures, guidelines, analysis techniques and templates for the evaluation of existing systems and environments (bridge, engine control room etc.) as a means of identifying potential or existing design problems. MarMet also provides procedures, guidelines templates etc. for use in the design development process of marine systems. MarMet represents in fact a fairly complete design and evaluation process as well as a systematic documentation system. At present the MarMet prototype methodology comprises 11 binders containing the various working templates for the various phases described in the following MarMet phase descriptions.

The MarMet process model is illustrated in Fig. 2 and has been defined as five major phases or modules.

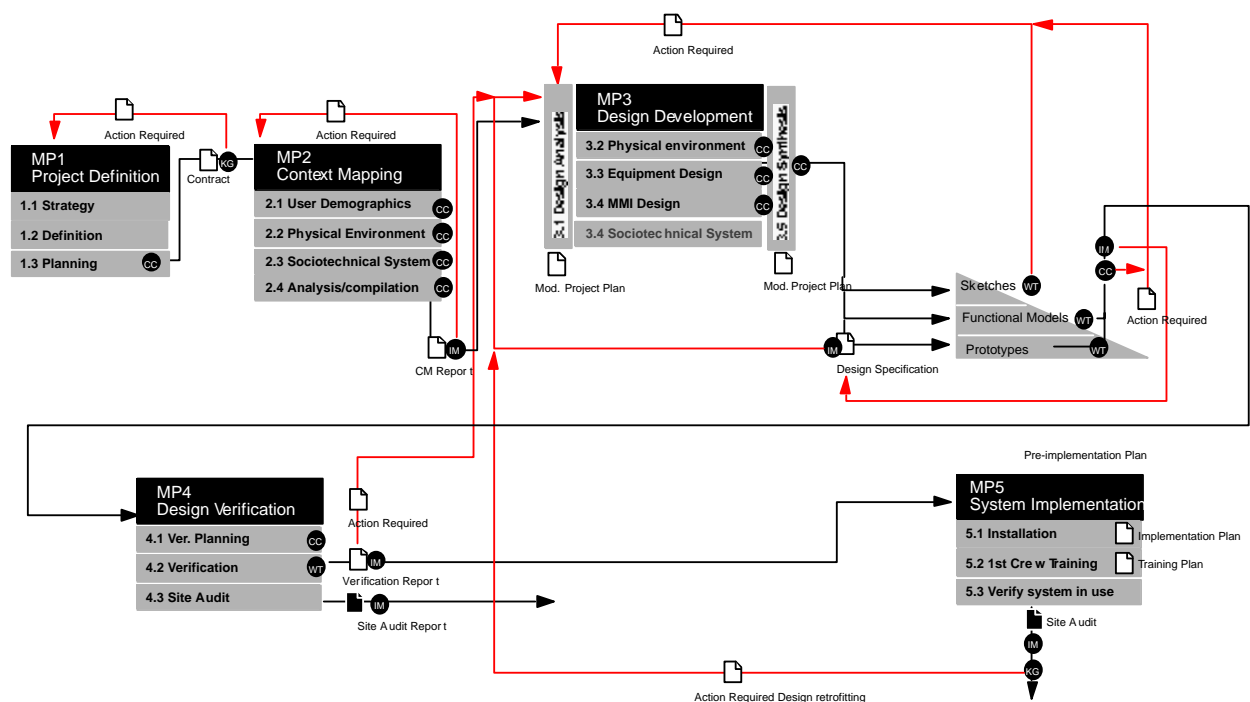


Fig. 2. The diagram above illustrates the MarMet structure as a number of phases. Each phase can be broken down into activities and then methods.

These phases as illustrated in Fig. 2 represent a complete development process. Yet the interesting aspect with MarMet is that the templates from the various phase activities and constituent methods may easily be mixed

and matched. For example one may take the mapping results concerning the bridge layout and components and combine it with a task analysis method in a new template.

6.3.1 MarMet Phase 1 (MP1): Initiation and definition

The first phase may be termed as the project definition and initiation phase. This phase and related activities starts a project and/or forms in particular situations a feasibility study. MP1 is also intended as a means of defining working and contractual factors as well as preliminary requirement specifications.

Generally this phase has the following goals:

- Establishing the scope of the project (what are we to do).
- Establishing a preliminary perspective and understanding of the work system (context) within which the system will function.
- Establishing a preliminary prioritisation of the main system goals (task, organisational, skill acquisition, security, and technical impact).
- Establishing the information acquisition techniques to be employed.
- Establishing a preliminary identification of the system users and interest spheres, the tasks to be performed etc.
- Establishing the system model.
- Establishing preliminary design procedure and work plan.
- Establishing the degree of system criticality in a malfunction situation and potential consequences necessary to determining the extensiveness of the quality control plan.
- Establishing quality assurance guidelines and quality control procedures.
- Establishing the preliminary verification and evaluation procedures in relation to the system goals.
- Defining and establishing the design group members, lines of communication between the system supplier and the client, professional qualifications of the group members, conflict solution mechanisms etc
- Establishing the budgetary constraints.
- Establishing the project time plan.

It is important to remember that the project will be defined by those constraints and possibilities stipulated by the client. In accordance with ISO 9001 this will determine the quality level of the results.

6.3.2 MarMet Phase 2 (MP2): Contextual mapping

Representing the detailed context of use the identification phase is somewhat equivalent to ISO/DIS 13407's first three phases. The major activities will include the user mapping, the physical environment mapping (including instrumentation and MMI) and the socio-technical system mapping.

User identification:

- Identify user attributes and demographics (demographic profile)
- Identify user's tasks
- Establish a sociographic profile
- Identify macro work environment (i.e. bridge, engine room "control spaces")
- Identify micro workstation environment (i.e. navigation, bridge wing)
- Identify equipment, instrumentation, computer systems and other related aids and tools
- Identify technical environment and configuration
- Identify physical environmental conditions
- Identify accident frequency and causal factors

Socio-technical environment:

The socio-technical environment may include mapping all or selected aspects of the work system i.e.

- Identify organisational structures
- Reporting procedures
- Identify macro work system process
- Identify micro work tasks, method and routines within the processes
- Identify attributes of the tasks (information, equipment, materials and procedures required)
- Work tempo (scenario variable) in high and low workload conditions, normal and abnormal conditions.
- Level of automation implemented and man-computer task allocation.
- Recruitment and redundancy policies
- Personnel selection and training programmes
- Work scheduling
- Watch keeping
- Career possibilities and advancement.
- Salaries, wage and benefit policies
- Personnel turnover, absenteeism, accident or sickness rates

- Operational statistics (stoppages, breakdowns class, reason and duration)

Physical environment

6.3.3 MarMet Phase 3 (MP 3): Design development

This phase involves both preliminary design development and detailed design development and therefore is titled as the Design Development Phase.

The design development phase or module is broken down into four components or sub modules. The appropriate phase or group of sub modules will of course depend upon the project's scope. These sub modules include:

- Design development of the physical work environment
- Design development of equipment
- Design development of the MMI

The results of a given design process may include three levels of design synthesis involving various levels of complexity and effort. This classification is imperative as a means of determining the scope of system realisation and of course costs.

These we define as:

- System sketches
- System models
- System prototypes

6.3.4 MarMet Phase 4 (MP 4): Design verification

Design verification can be described as short-term verification in conjunction with system development or long term evaluation in conjunction with in use systems. The second form we will refer to as site/system audits. A site audit is the examination of several factors – socio-technical, physical environment etc. A system audit is the evaluation of a particular given system only i.e. ARPA, conning display, joystick etc.

This module can be used in two ways. The design verification module may be employed in the design verification of a new system. Methods from MP4 may be used together with methods from MP2 in evaluation of existing sys-

tems. For example design verification checklists (MP4) might be used together with a user interview and a micro workstation mapping and analysis. Selection of the MP2 activities and methods will be determined in the project definition phase.

Here a distinction is made between design verification and evaluation. Verification comprises those methods and activities carried out during the design development phase to determine that the system meets task requirement goals. Evaluation is an activity carried out when the system has been installed and used over a period of time. Evaluation is intended to determine if the system meets the long-term system requirement specification.

6.3.5 MarMet Phase 5 (MP5): System implementation

Implementation involves the process of installing the completed system or equipment, user training and again an evaluation of the system in use. It was not intended to detail this module within the project framework.

MarMet is designed to provide a pragmatic working human factors based methodology platform incorporating e.g. the following features:

- An integrated design model and philosophy incorporating an MTO (man-technology-organisation) philosophy.
- A contemporary design process structure to assist in project planning, management and quality assurance processes.
- Ready made yet modifiable working templates to support the requirement specification, design development process and design verification activities.
- A set of formal methods for identifying design requirements, design development and design verification.
- Integration of applicable maritime design guidelines and standards as well as applicable and specifically adapted guidelines from the industrial sector.
- Adaptation and integration of various work system, task and MMI formal analysis methods (i.e. task analysis, risk analysis, MMI checklists etc).
- A prescriptive knowledge base to support and increase awareness of human factors issues in the design or evaluation processes.

- Adaptation and integration of a classification system for critical incident and human error in harmony with the design model.
- Collation and integration of established definitions and vocabulary.
- Modular to fit existing organisations and their development processes.
- Standard modifiable working templates permit easy transition to final reports.

MarMet should not be considered as a static final result. It can and will constantly be improved. Fig. 3 shows an overview of MarMet.

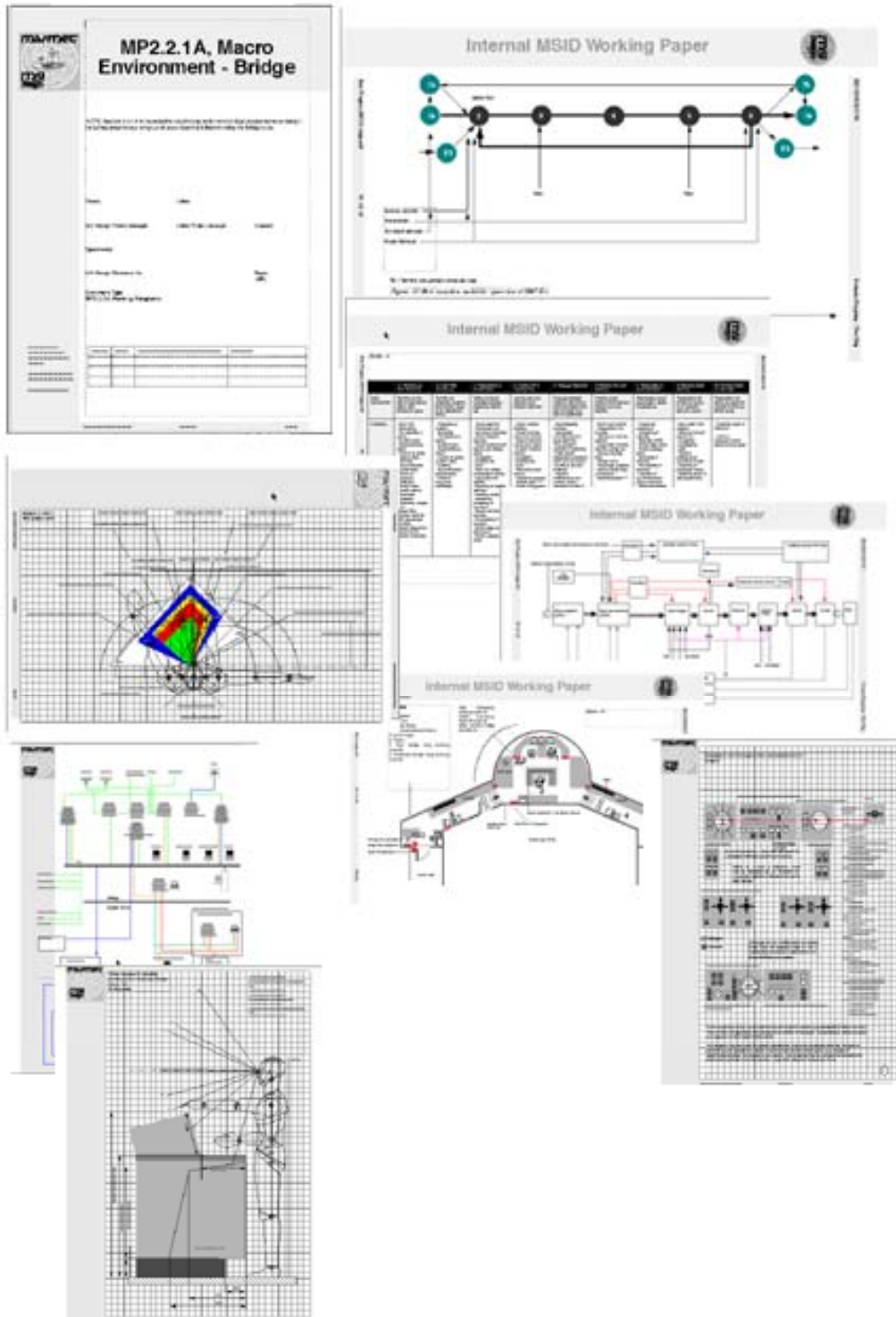


Fig. 3. A sample of templates comprising MarMet. The process involves a structured means of approaching human factors and design by starting at a macro level and the successively working down to a micro level i.e. individual control lever or indicator lamp.

6.4 Demonstration projects in WP3

As part of the SÄSAM project, MSI Design has concluded two major demonstration projects which constituted WP3's concluding activities. In addition a number of smaller individual method demonstrations were conducted together with Kalmar Maritime Academy and also with SSPA. For the two major demonstration projects, these involved applying MarMet as an evaluation tool for a stand alone radar system and an engine control room onboard an existing ship at sea.

6.4.1 The demonstration pilot projects: Background

The two pilot demonstration projects have been included to test and demonstrate the application MarMet's systematic and analytical procedures and templates in detecting potential human factors design related problem areas. Naturally the demonstration projects were intended to be conducted in a real life environment with existing systems and environments. This approach was intended to test a number of aspects regarding the MarMet procedures in these real life situations. The factors we wished to test included:

- Time required to conduct a stand alone system evaluation (radar)
- Time required to perform an on site survey (engine control room)
- The effectiveness of the procedures
- The contents of the procedures
- Structure and sequence of the procedure's various activities
- Analysis methods included as part of the procedures
- Time frames for compilation, analysis of data and findings preparation
- Effectiveness of the final report format

And not least the actual results or findings of the evaluations themselves as well as the participating company's response to the results.

Two such projects were discussed and identified as a result of a project Reference Group meeting. One demonstration would centre upon the evaluation of a stand alone system (radar system) and the other pilot project targeted an engine control room and included and would include and evaluation of the physical work environment, instrumentation, selected work procedures and tasks etc.

As a result of our request for participants within the maritime sector who deemed it of interest to facilitate such a pilot project - two companies

agreed to our conducting these projects as planned and with the targeted areas.

6.4.2 Demonstration 1: Evaluation of the user interface for a new radar system

The first pilot project involved the evaluation of a radar system interface which was under development. For this purpose a new MarMet module specifically targeted to radar system evaluations was created from the existing MarMet modules. This required a modest modification to include specific and detailed radar related guidelines. This process took four days. The actual data acquisition process using the new radar evaluation procedure involved four days at the manufacturer's lab with hands on use of the prototype system made specifically available for the purpose.

Three main pilot project phases:

- On site data acquisition of the system's MMI and physical hardware surrounding the MMI. A system prototype was made available for the data acquisition phase.
- Analysis of data and identification of potential problem areas.
- Compilation of final report 1st draft.

The radar evaluation entailed applying the MarMet procedure for a detailed examination of the user interface, functions and interaction methods including the following factors:

Radar Console

- Console, workstation design dimensions
- Work surfaces and surface treatment
- Work envelopes
- Reach envelopes
- Work postures
- Visual fields
- Visibility and distinguishability of instruments and controls
- Workstation lighting
- Instrument and control lighting
- Maintenance factors

Conventional Controls & Displays

- Functional instrument and control layout and groupings
- Labelling of functional groups, instruments and controls etc.

- Sequential ordering of instruments and controls within groups
- Instrumentation and control descriptions, placement and configurations (conventional MMI)
- Detailed instrument inventory (type, function, suitability)
- Detailed control inventory (type, function, suitability)
- Instrument and control design attributes
- Critical controls or instruments
- Labelling and terminology usage

Soft Controls & Displays

- Radar screen area layout and display format
- Detailed system display architecture and component subordinate displays (display type i.e. windows, function, access functions, format)
- Detailed display component inventory (type, function)
- Analysis of functional grouping and sequential ordering of display components
- Identification of all system MMI components (both conventional as well as soft controls and indicators) and their attributes such as feedback, coding techniques etc.
- Information coding techniques inventory
- Analysis of information design structures and techniques
- Analysis of analogue information design
- Analysis of alphanumeric or text information design
- Analysis of dialogue method and suitability
- Analysis of input device suitability
- Analysis of terminology usage
- Task and interaction analysis of selected scenarios
- Application of compliancy checklist

Compilation of the data and analysis was conducted in Sweden after the data acquisition phase in Italy and the findings presented at the company's head office in Sweden in August 2003.

6.4.3 Demonstration 2: Evaluation of an engine control room

The second demonstration project in WP3 entailed a systematic evaluation of a complete existing engine control room for a major world wide Swedish shipping company. This was deemed of interest in conjunction with the new ship acquisition process under way. Although we had originally targeted a bridge environment, the company felt it was of greater interest at this time to examine the engine control room particularly in light of new acquisition.

Therefore the goal was to conduct as extensive as possible an MTO evaluation of an existing engine control room and within given within time con-

straints. The time constraint was to determine what could be accomplished within a restricted budgetary framework. The time frame permitted for on-board data acquisition was restricted to 7 days.

The evaluation included auditing the following aspects:

- Physical work environment issues
- Layout and design of control room
- Instrumentation and control systems
- Task performance for selected main task clusters i.e. main engine start, finished with engines etc.

This change in initial goals required the development, again using the existing MarMet templates, of a particular site evaluation template entirely geared for engine rooms. This preparation required three days of effort.

On site data acquisition (7 days onboard) of the ECR (engine control room) suite including:

- ECR suite mapping, equipment, exits, lighting fixtures, ventilation devices
- ECR specific work zone mapping including workstations, general tasks, zone related equipment etc.
- Physical environment mapping (lighting, noise, temperature, humidity)
- Targeted workstation mapping including specific equipment
- Instrumentation and controls related to targeted work zones/stations
- Task analysis mapped against procedures and checklists
- Compliancy checklist

The site survey entailed spending 10 days aboard the targeted vessel and going through the data acquisition phase's various activities starting at a macro level (physical work environment, control room layout etc.) and proceeding to a micro evaluation level (instrumentation and controls).

The engine room evaluation involved a systematic examination of the physical work environment, the control room layout, equipment and design as well as conducting CIIA (control and indicator inventory analysis) analysis of the principle instrumentation and control systems. As a final step, a number of selected task scenario mappings were conducted for analysis against the physical environment, controls and instruments:

- Ancillary or adjacent spaces as required
- Space allocation for control room suite areas

-
- Space requirements for each functional area i.e. control room compartment, office compartment, pantry area, equipment compartments, main engine compartments etc.
 - Number and position of operators/crew per space during normal situations
 - Number and position of operators/crew per space including worst case situations
 - Space, movement envelopes and access for service and maintenance

 - Architecture/design
 - Space allocation to areas
 - Entrances and exits (emergency exits i.e. kick out hatches etc.)
 - Fire doors
 - Watertight doors, emergency kick out hatches, deckhead or deck hatches
 - Stairwells
 - Surface finishes
 - Grab rails

 - Workstation locations

 - Equipment locations
 - Emergency/alarm signalling devices (acoustical and visual)
 - Emergency equipment locations
 - Loudspeakers (internal PA systems)
 - Crew interaction with allocated equipment (NOTE: Requires preliminary task analysis procedure)
 - Crew interaction with other crew members ((NOTE: Requires preliminary task analysis procedure)
 - Movement and circulation patterns of crew or other personnel - normal conditions
 - Movement and circulation patterns of crew or other personnel - emergency conditions

 - Documentation storage, manuals etc.
 - Suitability of planned suite with consideration taken regarding:
 - Space restrictions
 - Hazards
 - Environmental factors (site measurements)
 - Lighting

 - Emergency equipment
 - Placement of wall mounted equipment
 - Communications equipment
 - Light switches, electrical outlets
 - Climate control units

- Warning or advisory information signage
- Dimensions of access corridors, crawl spaces, emergency kick out hatches etc.
- Visibility requirements
- Visual fields and lines of sight
- Visual contact with other crew members
- Visual contact with equipment, machinery etc.
- Distances between ECR/control room suites and equipment or process units, local workstations/control rooms

- Console, workstation design dimensions
- Work surfaces and treatment
- Work envelopes
- Work postures
- Visual fields
- Workstation lighting
- Equipment descriptions
- Functional grouping of instruments and controls
- Labelling and terminology
- Instrumentation, control descriptions, placement and configurations, conventional MMI
- Interdependencies between functional control groups or areas within the workstation
- Computer systems
- Task aids (documentation, tools etc.)
- Seating
- Maintenance factors
- Comprehensive control and indicator inventory analysis
- Analysis of tasks in relation to controls and indicators

With this data in hand the next phase involved analysis of some of some of the engineer's main tasks supported by these systems and the control room design. This involved using the official checklists and mapping these tasks against the equipment and task aids

The detailed compilation and analysis of the material was again done in Sweden. Using the site inventory templates, however now as the final report format, the initial draft report was prepared for the company and summarising the findings.

6.4.4 Results for the participating companies

The project results have been well received by both participating companies:

- In regards to the radar pilot project, the results provided a thorough and documented inventory of the radar system's functions, architecture, information design characteristics, targeted task performance measurements and mapping etc., and of course an inventory of potential problem areas.
- The site audit provided a relatively detailed inventory of the ECR's compartment's physical layout and design, component equipment, instrumentation and controls as well as the identification of potential physical hazards etc. In addition the drawings that were created complement the general arrangement drawings which often lack detailing. This material could easily be reusable for SMS, training, MMI component inventories etc. In addition the results provided input for future specification work in conjunction with new ship acquisition. Some results could directly be transferred directly to the specifications.
- The final report format which based upon the working templates proved quite effective and the transition to report form proved relatively simple. Here we had also set a standard in expectations.
- MarMet's procedures, methods and results can possibly be regarded as setting a standard for what shipping companies, equipment suppliers etc. should expect as a result in HF/MMI/HCI/MTO evaluations.

6.4.5 Other MarMet demonstrations

During the SÄSAM project a number of smaller methodology demonstrations were conducted to test individual methods. Some of these included:

- Sequential task analysis of student procedures during a bridge simulation at Kalmar Maritime Academy's bridge simulator in order to determine task frequency and equipment usage.
- Sequential task analysis of bridge procedures in an actual operative bridge environment and under way (leaving port) together with SSPA personnel.
- Testing the standard MarMet interview template for engineering crews in the UK by students at the University of Newcastle Upon Tyne.
- A small test of design development was done onboard the icebreaker ODEN and involved rapidly adapting a template for problem identi-

fication of a workstation. With this material in hand we produced a preliminary sketch series for a proposed redesign. We conducted a walk through based upon a MarMet technique of task procedures involved in landing helicopters which revealed small details that may have otherwise been overlooked.

6.5 Spin Offs

As a result of the reports produced in the demo projects in WP3 and subsequent discussions, a number of other areas for MarMet application were discerned and which were not originally considered as possible areas at the outset. As a result of the demonstration projects a great deal of reusable material was developed which could be further developed for other areas Spin off application areas from the material developed, either in evaluations or design development, or for that matter particular singular methods could also be used for:

- Developing training and orientation material for new crew
- Providing detailed equipment, instrument and control inventories for bridge decks and engine control rooms etc.
- Shipboard or company documentation materials
- ISM code documentation (i.e. procedures etc.)
- Procedure validation methods
- User manual development (for stand alone systems or shipboard procedures)
- Design verification material when submitting equipment and/or system designs for type approval by classification societies
- Specification criteria for yards and equipment suppliers
- Accident investigation techniques specifically aimed at MMI and work procedures
- A method for detailed MMI validation which is presently not done (only functions are tested but not use)

6.6 FREJ and ATOMOS IV: First commercial application of the MarMet methodology

The development of the MarMet methodology, as well as the completion of the two successful demonstration projects using the methodology resulted in MSI Design being commissioned by the Swedish Maritime Administration's Inspectorate to conduct an MMI (man-machine interaction) evaluation of the ATOMOS IV prototype installation on board the Swedish ice-

breaker FREJ. FREJ had been made available as a pilot installation site to demonstrate a retro fitted integrated bridge system developed under the EU sponsored ATOMOS project.

A total of three weeks were spent onboard FREJ conducting the data acquisition phase. This comprised gathering information concerning the physical work environment, console design, system MMI etc. In addition a number of selected task scenarios have been mapped and studied to determine the system's usability in operative conditions.

At present the first draft report is being compiled with delivery of the report scheduled for the beginning of June. This project represents the first commercial application of the MarMet methodology as a means of verifying human factors issues in an installed integrated bridge system. It also represents probably the first detailed examination or audit of an integrated bridge system's man-machine interface. Although the classification societies conduct functional testing of equipment prior to type approval, there appears to be no procedures for validating the man-machine communication aspects of control or information systems.

6.7 Summary comments of WP3

As a result of the work conducted during SÄSAM and, of course, the completion of WP3, a number of conclusions may be made. These may be summarised as:

- The question of the instrumentation and control systems inducing human error (technology induced error), remains somewhat of an unexplored region. In effect the officer of the watch can commit himself to an action that he or she considers correct based upon those system's MMI and poor design. This may involve such issues as visibility, interpretation, distinguishability, mode error, timing errors, description errors etc. In the demonstration projects the application of MarMet working procedures as well as guidelines have discovered latent design problems not otherwise noticed. This was evident during the presentations of the results.
- Many IT solutions upon more detailed analysis often reveal a lengthy series of procedural steps involved in order to accomplish a relatively simple task i.e. shifting a pump from master to slave status. Visual search time is often greatly increased.
- There prevails an erroneous assumption that deck officers are trained in the systems that they will use. This is often not the case. It becomes a situation of learn by trial and error, reading manuals or

asking colleagues. Training appears to be the exception to the rule. Here the question is how intuitive are high tech MMI solutions in facilitating user learning. Therefore a system's MMI should be designed for this worst case situation.

- The increased application of information technology in itself does not guarantee optimal MMI. In fact during the work with SÄSAM most such systems display common problem areas. Although information technology does permit the integration of many different information sources and if properly done, in novel new ways, the MMI is often of a poorer quality than the old conventional systems. In addition many new error sources may crop up often described by the term bug.
- There is no lack of design guidelines. One of the major tasks in SÄSAM's WP3 has been to compile this multitude of guidelines from many different sources into one common framework. Under the issue of software MMI, we have compiled approximately 1300 items in the compliancy checklist. The issue is not that there are none, but rather that they are not being necessarily observed or for that matter remain relatively unknown.
- User trials are one method of validating designs, however one may not get at all the necessary details of an MMI design's various factors. This is particularly true when addressing those issues covered by guidelines. These details may include information coding, menu structures, safety lock sequences or alarm handling. This can only be done by the analyst working in a systematic manner and addressing a broad range of issues one bit at a time. Therefore a reasonable approach combines both user trials and the analyst.
- In the type approval process conducted by classification societies, it appears that the effectiveness of the MMI is not tested. Only the function tests are conducted. In effect the systems installed aboard have not been tested for usability and potential problem areas in respect to MMI.
- A great deal of effort has been expended during the years on the bridge deck environment. This is evident through the number of established guidelines for the design of bridge decks. However, the engine room is a relatively unknown factor. When conducting the pilot project and setting up the necessary evaluation modules, we found little available regarding engine rooms and in particular control systems. However we found that a great deal of material from the industrial process control sector combined with elements from the bridge design guidelines could effectively be combined to prov-

ide the evaluation module. In effect we have put together a basic platform for human factors design in engine control rooms.

- The data acquisition process onboard a vessel will require about three weeks with the data compilation being the most time consuming part of the evaluation process.
- In order to determine how well an environment, equipment and systems support task performance you must first have an idea on what the environment and tools consist of and then conduct the task analysis. In the design process the task analysis is done first. Generally we have found that the tools and methods that make up MarMet may be effectively used both for design development and evaluation purposes.
- The two demonstration projects and their requirements enabled testing MarMets flexibility. Here we could put together completely new methods to meet these requirements within approximately 4 days. In addition the demonstration projects resulted in some modifications to the procedure's sequence of activities to more adequately reflect a smooth data acquisition process.

7 WORK PACKAGE 4: INTEGRATION OF THE INFORMATION ON THE BRIDGE

WP-leader: SSPA Sweden AB

7.1 Introduction to WP4

This Chapter summarizes the final results of WP4. The focus was on the bridge and the different types of equipment used for steering a ship. The approach in WP4 was, together with WP1, WP2 and WP3, to achieve a holistic view of ship steering.

Special attention was given to the following topics:

- Radar systems (together with WP3)
- Automatic Identification Systems (AIS)
- Electronic Chart Display and Information Systems (ECDIS)
- The integration of radar, AIS and ECDIS information
- Development of a new method for evaluation of ship manoeuvring margin

7.2 Integration of radar, AIS and ECDIS information

The focus for this study is radar, AIS (Automatic Identification System) and ECDIS (Electronic Chart Display and Information System) design aspects with respect to the interface and the interaction with the operator. These systems have a very central role on the ship. Its function and management is of greatest importance in order to achieve efficient, safe and good environmental conditions for humans, society and property. Some preliminary findings are given in Wilske & Grundevik (2002) (in Swedish). The integration of radar, AIS and ECDIS information and how to present the selected information is the main outcome in this study. The study is reported in detail in Grundevik & Wilske (2004). A summary follows.

ECDIS system usage has been investigated through questionnaires and radar systems interfaces have been evaluated on site. The role of the radar in some accidents and incidents has also been studied. Proposals

and present regulations for display of AIS information have been analysed as well. The objective has been to study the integration of information and identify some drawbacks and possible solutions in the interaction with the human being. Some recommendations and guidelines are also presented for integration of radar, AIS and ECDIS information into a common unit for control and presentation. The inclusion of human factors approach in the design process as well as include the end-users/mariners is believed to give better solutions to the existing problems. Some important conclusions are that

- the different system information is handled comprehensive in an integrated view and the joint hazard of collision and grounding shall be presented on one display,
- the presented information shall be sparse and information overload is dangerous,
- there shall be short series to receive desirable information and interface management tasks during high-tempo situations shall be avoided,
- multiple senses display alternatives should be considered in addition to graphics and text.

7.3 Development of a new method for evaluation of ship manoeuvring margin

When analysing the manoeuvring difficulties during a fairway transit one have to consider a vast array of variables. There is an obvious difficulty to weight these variables to form a compound assessment of the manoeuvring difficulties. This lead often to that the in the end one have to rely on subjective assessments. In this study efforts have be made to create a method that is doing this assessment based on the ship manoeuvring capacity, fairway limitation and impact from wind and current and form this into a single index. The keystone in the method is the generation of a solution space. This is simply a matrix of simulations result where steering device have been systematically varied in all combination in a number of steps. The study is reported in detail in Wilske (2004).

The solution space is evaluated both with respect to rudder angles and with respect to position in the final step. See Fig. 4. The evaluation of the solution space with respect to rudder angles is shown to give valuable information of the ship's ability to proceed in the fairway and the what rudder angle that representing most number of successful solu-

8 CONCLUSIONS

There are many conclusions to be drawn from the SÄSAM project. Some of the more important are:

- Integrated bridge designs should be based on how the work tasks on the bridge are carried out in reality, i. e. the design should be based on integration at the human level, not on a technical level.
- The different system information from radar, Automatic Identification System (AIS) and Electronic Chart Display and Information System (ECDIS) is to be handled comprehensive in an integrated view and the joint hazard of collision and grounding shall be presented on one display.
- MarMet is a valuable, human factor based tool for systematic design and evaluation of bridges, control rooms, and equipment.
- Augmented reality has the potential of improving the safety in ship steering, but substantial development work is required.
- There is a positive attitude and high motivation, interest and engagement amongst Swedish officers and cadets for all issues that can be related to safety, but deviations from safety regulations are accepted at times. Further research to investigate, understand and improve the situation is required.
- The SÄSAM project has created an important Swedish network on human factor and safety aspects in the maritime field. The Swedish network is already expanding in the Nordic/Baltic (Nordic Transport Research) and EU Framework Programme domains.

9 REFERENCES

Barchéus, F. (2002): "Integrated instruments and augmented reality on high-speed craft", Master Thesis at the Division of Work Science, Department of Industrial Economics and Management, Royal Institute of Technology, Sweden, 2002.

Bergquist, C., Brandel, C. & Åsenholm, A. (2004): "SÄSAM. Mätning och verifiering av attityder till sjösäkerhetsfrågor", (in Swedish) Rapport Sjöfartshögskolan i Kalmar, 2004.

Erlandsson, M. & Jansson, A. (2004): "Augmented reality as a navigation aid for the manoeuvring of high-speed crafts", Proceedings of International Design Conference, Design 2004, Vol. 2, Sveuciliska tiskara, Zagreb, Croatia, 741-748, 2004.

Grundevik, P. & Wilske E (2004): "Integration of radar, AIS and ECDIS information", SSPA Research Report No 128, 2004.
ISBN 91-86532-41-3, ISSN 0282-5805

Jansson, A., Barcheus, F. & Erlandsson, M. (2004): « Dynamic decision making in traffic systems: One and the same model for the control task and the operator strategies». Paper to be submitted to Behaviour & Information Technology or Journal of Behavioural Decision Making, 2004.

Källström, C (2000): "Människa-maskinfrågor och säkerhet i samband med styrning av snabba fartyg" (in Swedish with an English summary), SSPA Research Report No 115, 2000.
ISBN 91-86532-28-6, ISSN 0282-5805

Olsson, E., Seipel, S. & Jansson, A. (2002): "Safer navigation at sea using augmented reality", Proceedings of HCI'02, People and Computers, Vol. 2, Springer Verlag, London, UK, 154-157, 2002.

Olsson, E., Seipel, S., Jansson, A. & Sandblad, B. (2002): "The windscreen used as a display for navigation information: An introductory study". Technical report, nr. 2002-017, Department of Information Technology, Human Computer Interaction, Uppsala University, Sweden, 2002.

Olsson, E (2004a): "Designing work support systems- for and with skilled users", Acta Universitatis Upsaliensis. *Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology* 983. 76 pp. Uppsala, 2004.

ISBN 91-554-5977-3, ISSN 1104-232X

Olsson, E. (2004b): "What active users and designers contribute in the design process", *Interacting with Computers*, 16 (2), 377-401, 2004.
<http://authors.elsevier.com/sd/article/>

Olsson, E. (2004c): "On design of a high-speed ferry bridge", Submitted to *Behaviour & Information Technology*, 2004.

Olsson, E. & Jansson, A. (2004): "Work on the bridge – studies of officers on high-speed ferries". Submitted to *Behaviour & Information Technology*, 2004.

Wagner, E (2000): "Human-machine interaction and safety when controlling fast ships, Part III – An attempt to develop a working human factor methodology", RINA Intern. Conference on "Human Factors in Ship Design and Operation", September 2000, London, UK.

Wagner, E. (2004): "Final report for SÄSAM WPIII, MarMet HF based design process, methods and guidelines for marine systems", MSI Design 0016, 2004.

Wilske, E. & Grundevik, P. (2002): "Reserapport från SMM-2002", (In Swedish) Internal SSPA Rapport 2002.

Wilske, E. (2004): "A new method for evaluation of ship manoeuvring margin", SSPA Research Report No 127, 2004.
ISBN 91-86532-40-5, ISSN 0282-5805

**10 APPENDIX: CONFERENCE “MARITIME SAFETY AND
THE HUMAN FACTOR”**



Invitation

Maritime Safety and the Human Factor

May 18, 2004, at Kalmar Maritime Academy, Kalmar, Sweden

The program contains presentations from Nordic and Baltic countries and a discussion, under the guidance of VINNOVA (Swedish Agency for Innovation Systems) and NTF (Nordic Transport Research), about Nordic/Baltic co-operations in “Maritime Safety and the Human Factor”. New project ideas for increasing the safety in the Baltic Sea will be the focus. Results from the project “SÄSAM- Safety and human-machine interaction in waterborne transport” within VINNOVA’s Maritime Safety Programme, with financial support also from the Swedish Maritime Administration and the Swedish Mercantile Marine Foundation, will be given, as well as results from other VINNOVA projects.

There is no participation fee. The language is English.

Detailed program will be distributed later, but please reserve May 18, 2004!

Welcome!

The SÄSAM Project

SSPA Sweden, Project Manager

Kalmar Maritime Academy

Information Technology/Human-Computer Interaction, Uppsala University

MSI Design

Information about SÄSAM and the program:

Claes Källström, Vice President, SSPA Sweden: +46 31 772 9050 or claes.kallstrom@sspa.se

Practical information:

Cecilia Brandel, Kalmar Maritime Academy: +46 480 49 76 45 or cecilia.brandel@hik.se



Program

- 0800–0815 Gathering, coffee
- 0815-0830 **Introduction**, Claes Källström, SSPA Sweden, and Christer Bergquist, Kalmar Maritime Academy
- 0830–0855 **Human Error and Human Capacities**, Bengt Schager, Marine Profile, Sweden
- 0855–0910 **Resource Management, Developing Individual Resources**, Ulf Samuelson, Silja Line, Sweden
- 0910-0935 **The human factor in marine accidents**, Tõnu Remma, Maritime Administration, Marine Casualties Investigation and Maritime Safety Development Department, Estonia
- 0935–1000 **Maritime Safety – the Chalmers’ way**, Monica Andersson, Maritime Academy Chalmers Lindholmen, Sweden
- 1000-1020 Coffee
- 1020–1040 **On the bridge: Studies of officers’ strategies and information environments on high-speed ferries**, Anders Jansson or Eva Olsson, MDI, Uppsala universitet (SÄSAM, project 1)
- 1040–1100 **Attitudes towards Safety amongst active Officers**, Christer Bergquist, Kalmar Maritime Academy (SÄSAM, project 2)
- 1100–1120 **The MarMet Methodology - practical demonstrations for evaluation of an engine control room and a radar system MMI**, Eric Wagner, MSI Design, Sweden (SÄSAM, project 3)
- 1120-1140 Estimation of ships manoeuvring margin**, Erland Wilske, SSPA Sweden (SÄSAM, project 4)
- 1140-1240 LUNCH
- 1240-1305 The human element and man-machine interaction related to VTS centre operations**”, VTT, Finland
- 1305-1330 **Measurement of stress and mental activity among maritime crew members**, Peter K. Sørensen, FORCE Technology, Denmark
- 1330-1355 **Integration work on the bridge: Human – machine interaction**, Margareta Lützhöft, Linköping University, Sweden
- 1355-1420 Risk communication onboard passenger ships: Special consideration of design issues**, Kjell Ohlsson, Linköping University, Sweden
- 1420-1440 Coffee
- 1440-1505 **Emergency Announcements over the PS System**, Nicklas Timstedt, Marine Profile, Sweden
- 1505-1530 **The ISM-Code, does it work or not?**, Göran Jense, Växjö University, Sweden
- 1530-1700 **Discussion on Nordic/Baltic co-operation in “Maritime Safety and the Human Factor”**, VINNOVA and NTF
-