D9.1 Guidelines

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Partners involved

No.	Organisation Name	Name	Email
1	Stichting Projecten Binnenvaart	Khalid Tachi	k.tachi@eicb.nl
2	MARIN	Meeuwis van Wirdum	m.van.wirdum@marin.nl
3	DST	Erwin van Heumen	heumen@dst-org.de

Document history

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1.0	2014/10/31		E. van Heumen, M. van Wirdum, W. de Boer, B. Kelderman, I. Backalov, L. Molter, M. Godjevac, K. van der Meij, B. Holtmann, A. Bons	M. van Wirdum

Table of Contents

1 Introduction

For the dissemination of the results of the research performed within the MoVeIT! project to ship-owning companies, guidelines for ship-owners were developed. They were based upon the outcome of the previous WP's 2-7 as provided from the respective partners and include the following elements:

- Modernisation elements
- Their effect on cost efficiency
- Their effect on energy efficiency
- Their effect on safety standards
- Their effect on operating areas

Practical elements were given so that they can be directly used by ship owners. The guidelines will be disseminated in a manual available for all ship owners.

These guidelines were developed under the lead of DST and in cooperation with the respective WP-leaders. They are enclosed in the annexes of this document and have been published at the MoVeIT! website.

1.1 Considerations

In the development of the guidelines the general experiences and outcomes of the MoVe IT! were considered, concerning that:

- A huge variety of retrofit options exist, but there is no single best solution for everyone;
- In most cases ship-owners have possibilities to reduce fuel consumption and emissions. So, improvement in performance is expected at first sight.
- The judgement whether the benefits of a retrofit solution are worth the costs is company/ship specific.
- In many cases retrofit solutions simply don't earn-back themselves fast enough, in spite of substantial improvement in performance.

So, guidelines can provide quick and basic information on the (dis)advantages and the costs and benefits of the researched solutions. However, the effectiveness of most of these solutions is determined by aspects like the vessel type/class and its operational profile.

1.2 Targets

With regards to these considerations the guidelines were meant to summarise the core results and provide ship-owners and shipping companies with:

- Support in the decision on refit options;
- Overview of suitable refit options with return on investment;
- Case study based results of these options;
- Contact details of experts that can give further advice on these options.

For further details, also the respective deliverables of the corresponding work-packages can be consulted.

1.3 Booklets

To provide ship-owners and shipping companies with this information six digital booklets have been made. In five of them a particular aspect of the vessel is highlighted, this follows the division of the WPs 2 – 6 and all of them use also the data from the assessments performed in WP7. Together with a booklet on the general guidelines this resulted in these six booklets:

- General guidelines
- Hydrodynamic Improvement (WP2)
- Energy Efficient Operation (WP3)
- Powering & Engines (WP4, 7)
- Structures & Weight (WP5)
- New Scales & Services (WP6)

2 Content of the guidelines

To provide a comprehensive and clear overview of the possible refit options, each WP is represented by a separate booklet. This resulted in five booklets, representing the WPs 2-7 and much of the data used in these booklets are based on the outcomes of these WPs in combination with the data from the economic and environmental assessments from WP7.

2.1 General guidelines

In the general guidelines the general outlines of the guidelines, an overview of the booklets is given. This booklet is added to the five booklets of the WPs as an overall guidance for the reader, as it explains the connection between the other booklets and how to read them.

2.2 Hydrodynamic improvements

The booklet on the options to improve the hydrodynamic performance of a vessel is based on the research performed in WP 2, as everything aboard (inland) ships is eventually affecting its hydrodynamics: structural weight and payload needs to be carried by the vessel's displacement and hydro-dynamic resistance directly affects machinery and power. Even operation, loading and consumption of prime energy resources will by their effect on trim and the inherent effect on resistance affect the ship's performance. Low fuel consumption and efficient ship operation thus starts with a proper hydrodynamic design.

2.3 Energy efficient operation

The booklet on the options for energy efficient operation is based on the work performed in WP3. This is mainly focused on the application of the of measuring equipment onboard of inland ships in order to monitor the operational profile and to collect available water depths. Further, the ship operation can be made more efficient by using an EconomyPlanner software, a small investment enabling durably fuel savings.

2.4 Powering & engines

The booklet on the powering and engine room options is based on the research performed in WP 4 as well as WP 7. In this booklet a description is given of the modernisation of the ship´s power system in a way that is matched to the conditions it will face throughout its life. Renewal of the existing engines is can be a suitable retrofit option to meet future emission requirements, but a rather long payback periods are to be considered. Exhaust gas after-treatment like catalysts and/or filters are alternatives if shorter economic horizons are regarded.

2.5 Structures & weight

The booklet on structures and weight is based on the research performed in WP 5 and focusses on the application of novel materials and designs to the ship´s structure of single hull tankers in order to meet future safety regulations and operational requirements. Further, the cargo capacity of inland ships can be effectively increased by lengthening the ship hull with lightweight materials and designs. This leads to higher transport efficiency with a positive return on investment.

2.6 New scales & services

The booklet on the options for new scales and services is based on the research performed in WP 6, amongst others it focuses on the upgrade of smaller ship types. The cargo capacity can be effectively increased by lengthening the ship hull with conventional methods This leads to higher transport efficiency with a short return on investment. Further, cost effective adaptation measures are found to cope with negative effects of climate change. Adaptation of inland ships to transport CO_2 gas, however, shows not to be an economically feasible retrofit option.

3 Design of the guidelines

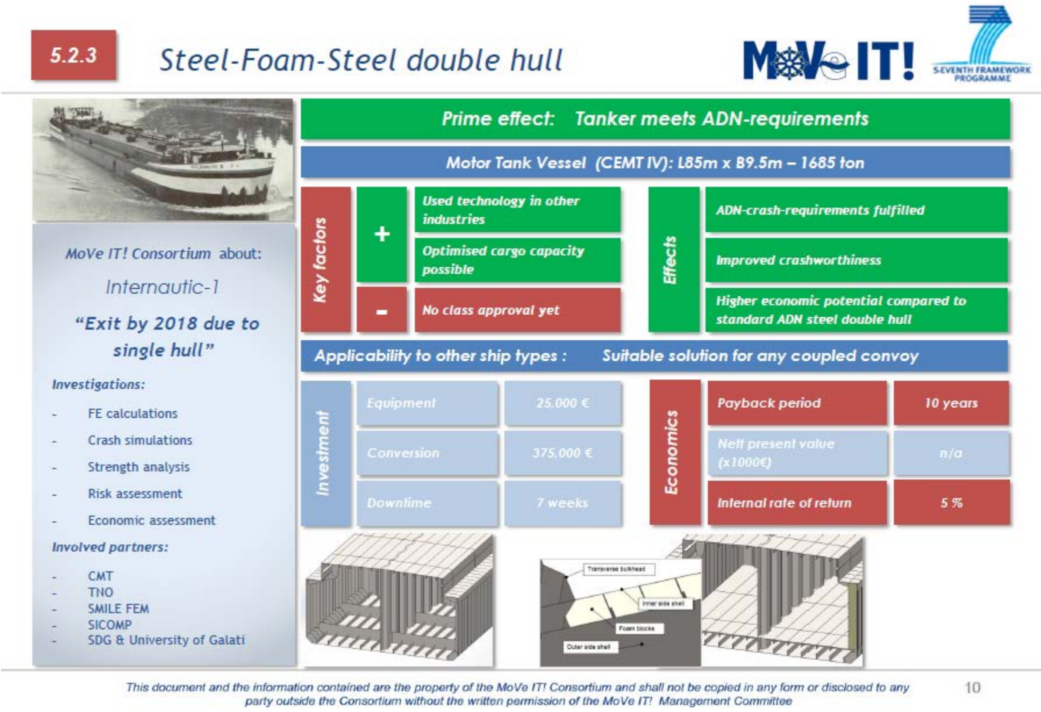
3.1 General structure

The guidelines booklets are structured in a quite similar way, starting with a general introduction about the project and in each of the booklets an introduction about the topic and the possibilities for improving the (use of the) vessel. Hereafter all the refit options are shown.

3.2 Overview per option

For each option a similar overview has been made. This consists of:

- Left bar: A brief outline of the research and the case study performed, e.g. the vessel on which the research was performed, the investigations performed and the involved partners
- Main frame:
    - The prime effect of the option;
    - The type of vessel on which the case is based;
    - The key factors, the (dis)advantages of the option;
    - The effects of applying the option (positive as well as negative);
    - The applicability of the option to other ship types (important information for a ship-owner whether it is an interesting option for him to consider);
    - The investment of applying this option (in this case), split in:
        - the equipment costs;
        - the conversion costs;
        - and the downtime.
    - The economics, expressed with some capital budgeting ratios, i.e.:
        - the payback period;
        - the net present value;
        - and the internal rate of return.



1 Example of first slide of option overview, i.e. Steel-foam-steel double hull

3.2.1 Second slide

On the second slide more detailed information is given on the option and the case researched within the MoVeIT! project:

- A brief description of the retrofit option;
- The background of the business case investigated within the MoVeIT! project;
- The technical feasibility and technological maturity of the option (e.g. is the option a proven technology);
- The bandwidth of the gains, investments and effects;
- The conditions and boundaries for the application of the option;
- The actions needed to be performed for applying the option;
- The applicability to other ship types;
- The contact details of the expert.

2 Example of second slide of option overview, i.e. Steel-foam-steel double hull

3.3 Lessons learned

For the general conclusions on each of the research topics, each of the booklets have some 'lessons learned'. These are mostly involving the refit options, their feasibility and which of these options have the biggest potential.


5.3 Lessons Learned

MoVe IT! SEVENTH FRAMEWORK PROGRAMME

Lesson 1: "Novel materials and alternative structural design can make inland ships safer and more effective!"

The structural modifications and options are suitable for retrofitting as well as for the application in new-building designs. From a technical point of view all suggested solutions are feasible considering global and local strength of the hull with some minor issues which can be solved.

Lesson 2: "Conventional steel structures are most suitable for retrofit purposes"
In spite of the better economical performance against steel structures, the implementation of novel materials to existing ships may be difficult as time-consuming effort has to be made to convince the classification societies and authorities.

Lesson 3: "Novel materials have large potential for new-building projects"
The introduction of novel materials to inland ships may be easier in case of new-building projects as the design can be optimised to it. Another advantage is that the costs due for research & development and type/product approval may be spread over multiple ship orders.

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3 Example of lessons learned, i.e. Booklet 5

3.4 Colophon

For further information on the matters discussed in the booklets each of the booklets have some contact details of the project coordinator, the particular WP leader and the parties involved in dissemination and the guidelines.


Colophon

MoVe IT! SEVENTH FRAMEWORK PROGRAMME

For more information about New Scales & Services

Please contact:

Dr. Igor Bačkalov, Dipl.-Ing. MRINA
Assistant Professor

Department of Naval Architecture
Faculty of Mechanical Engineering
University of Belgrade

Kraljice Marije 16
11120 Belgrade 35, Serbia

T: +381 11 3229 281
F: +381 11 3370 364
E: ibackalov@mas.bg.ac.rs

For more information about the collaborative project or one of the work packages

Please contact:
Project Leader MoVe IT!

Mr. Meeuwis van Wirdum
MARIN – Team IWT
Project Coordinator

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 39 11
E: inlandship@marin.nl

www.moveit-fp7.eu

These guidelines are part of Move IT! dissemination

The guidelines are created by Erwin van Heumen, DST, on the basis of the work realised in the project.

Please contact:

DST - Development Centre for Ship Technology and Transport Systems
Department Transport Systems
T: +49 (0)203 99 369 -51
E: scholten@dst-org.de
P.O. Box 10 13 49
47013 Duisburg
Germany

Stichting Projecten Binnenvaart (SPB) lead Move-It dissemination. For questions on dissemination you can contact SPB through the project coordinator or directly via: b.kelderman@binnenvaart.nl

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4 **Example of the colophon, i.e. of Booklet 6**

Annexes: Guidelines

Guidelines on Modernisation of Inland Ships

In order to improve inland waterway freight transport to the standards of tomorrow, inland shipping needs to MoVe IT!

August 2014
MoVe-It Consortium
http://www.moveit-fp7.eu/

Themes		Booklet
	General Guidelines	1
Themes	Hydrodynamic Improvement	2
	Efficient ship operation	3
	Powering and Engines	4
	Ship Structures & Weight	5
	New Scales and Services	6

Introduction

"In order to improve inland waterway transport to the standards of tomorrow, inland shipping needs to MoVe IT!"

- Meeuwis van Wirdum – Project leader -

Objective of these guidelines

• • •

The Move-IT project learned that in most cases you as a shipowner have possibilities to reduce fuel consumption and emissions. This guideline helps you to explore your options and helps you to judge whether the benefits are worth the cost. This judgement is company/ship specific. For advice or help you can contact the one of the partners of Move-IT.

What is MoVe-It?

• • •

Strengthening the future of existing IWT vessels by investigating retrofit options from both a technical and an economical perspective. MoVeIT! is a European research project. The project closely looks into vessels and their performance and develops a set of viable options for modernisation. These options will allow these vessels to meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

One of the main focal points of MoVe IT! is the modernisation of the ship´s drive and power system in a way that is matched to the conditions it will face throughout its life. This will result in significantly better performance compared to the ships old systems that are designed to fulfil a single design condition.

Contents

"MoVe IT ! Investigated multiple refit option.

They are sorted in the following categories"

How to read this guidelines?

...

In the booklet retrofitting option are presented as selected case studies that demonstrate the technical and economical feasibility of the solutions as decision aid.

About performance of IWT

What is Performance?

• • •

When an attempt is made to improve inland ships, people often speak about improving its performance, but what does that mean?

By using the word 'performance' we try to indicate how well a ship does what it is supposed to do. So, if we talk about good manoeuvring performance, we could mean that the ship has good directional stability, but also has a small turning circle. If we speak about good economic performance, this usually means that the ship can transport things cheaply or that you can earn a lot of money with it.

And how to improve it?

• • •

The Move-IT project learned that in most cases you as a ship owner have possibilities to reduce fuel consumption and emissions.

This guideline helps you to explore available modernisation options and helps you to judge whether the benefits are worth the cost. A green/orange/red indicator gives you a quick impression of the feasibility of the investigated refit options. For advice or help you can contact the one of the partners of Move-IT.

What MoVe-It did

• • •

We closely looked at five existing vessels and how they are operated; took full-scale measurements of key performance indicators and then developed viable options.

This way not only a clear set of optimisation options can be presented, also the owner benefits from a higher insight in the performance of his vessel and the influences applicable. By doing so, even if the option itself is decided to not be implemented at this moment, the vessel owner gains a higher awareness of the added value and the way to look at his vessel, helping him to more closely look into options like these at the moment his business allows him to invest..

How to decide?

Payback period:

Ship owners indicated that the duration of the pay back period is crucial in their decision making process. For each of the options analysed, it is determined whether the option is feasible from the perspective of the ship owner.

- *Highly feasible retrofit option: payback (period between 1-5 years)*
- *Option could be considered (payback period between 6-10 years)*
- *Retrofit option is not a viable option (payback period of more than 10 years).*

Internal Rate of Return (IRR):

This indicator measures and compares the profitability of different options or more specifically the IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment. The higher the IRR is, the more profitable it is to invest in a retrofit option.

The criterion for feasibility is that the IRR has to be larger than the applied interest rate. In our cases 5.5%.

Net Present Value (NPV):

This indicator is often used in policy related decisions and indicates the 'difference amount' between the sums of discounted: cash inflows and cash outflows. It compares the present value of money today to the present value of money in the future, taking inflation and returns into account. The higher the value of this indicator the more attractive it is to invest in the retrofit option. (For this economic parameter should be we did not declare a threshold value.)

Lessons Learned

Lesson 1: "In most cases ship owners have possibilities to reduce fuel consumption and emissions. So, improvement in performance is expected at first sight."

Refit options with the largest effect on the fuel consumption or on emissions of your ship may lead to an investment that will not improve the financial performance of your ship.

A cost benefit analysis is needed before you can decide if the investment weigh the costs.

Lesson 2: "There is no single best solution for everyone"

All ships are different, ship owners and shipping companies are different and the way each ship is used is different. So don't just copy what someone else is doing, but analyse your own situation and investigate what could be the best option for your ship.

The participants of MoVe IT! can help you with that.

Colofon

For more information about these guidelines

Please contact:

DST - Development Centre for Ship Technology and Transport Systems
P.O. Box 10 13 49
47013 Duisburg
Germany

T: +49 (0)203 99 369 20
F: +49 (0)203 36 13 73
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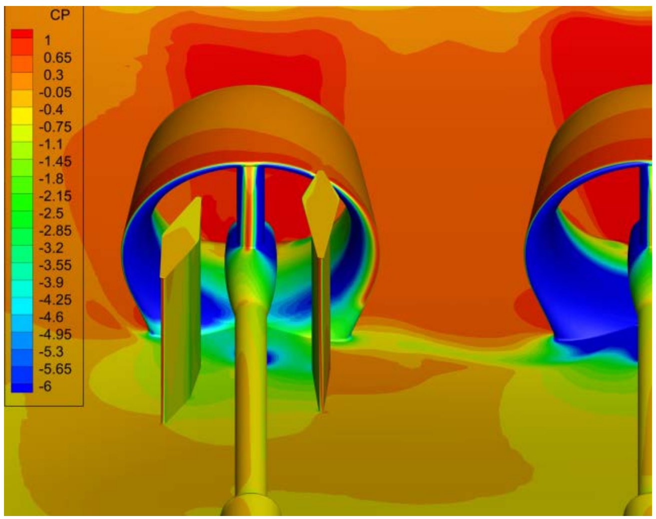
Guidelines on Modernisation of Inland Ships

In order to improve inland waterway freight transport to the standards of tomorrow, inland shipping needs to MoVe IT!



		Booklet
	General Guidelines	1
Themes	Hydrodynamic Improvement	2
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August 2014
MoVe-It Consortium
http://www.moveit-fp7.eu/

"In order to improve inland waterway transport to the standards of tomorrow, inland shipping needs to MoVe IT!"

- Meeuwis van Wirdum – Project leader -

Objective of this guidelines

• • •

MoVeIT! is a European research project, in which a set of options is developed for the modernisation of inland ships that meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

Hydrodynamic Improvements

• • •

Everything aboard (inland) ships is eventually affecting its hydrodynamics: structural weight and payload needs to be carried by the vessel's displacement and hydrodynamic resistance directly affects machinery and power. Even operation, loading and consumption of prime energy resources will by their effect on trim and the inherent effect on resistance affect the ship's performance. Low fuel consumption and efficient ship operation thus starts with a proper hydrodynamic design.

What's MoVe-It! ?

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Strengthening the future of existing IWT vessels by investigating retrofit options from both a technical and an economical perspective. MoVeIT! is a European research project. The project closely looks into vessels and their performance and develops a set of viable options for modernisation. These options will allow these vessels to meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

One of the main focal points of MoVe IT! is the modernisation of the ship´s drive and power system in a way that is matched to the conditions it will face throughout its life. This will result in significantly better performance compared to the ships old systems that are designed to fulfil a single design condition.

Table of Contents

"Well-chosen hydrodynamic improvements can improve the performance with return on investment"

How to read this guidelines?

...

Selected case studies demonstrate the core results in terms of technical and economical feasibility. For detailed information, please refer to Deliverables 2.1 — 2.2 and 7.1 — 7.3

Introduction

Problem definition:

Hydrodynamic performance is a multiplying factor to most of the potential improvement measures e.g. improvement of the engine exhaust. If more efficient propellers or reduced resistance of hull and appendages lead to significant savings, this is multiplied with the for instance improved engine efficiency and will pay back every hour the vessel is sailing. The same holds for enlarged cargo transport capacity at acceptable hydrodynamic performance such as fuller but optimised hull lines or a lengthened vessel.

The impeding factor is the demanded suitability for retrofitting, which is not only seen technically but also financially and economically.

	Modification options	Case	Ship type
Propeller upgrade	Pump Propeller	2.2.1	Rhine-Herne canal vessel
	Pump Propeller	2.2.2	Canal push boat
Improved inflow	Flanking rudder removal	2.3.1	Danube push boat
	Nozzle strut reduction	2.3.2	Canal push Boat
Modified hull shape	Smoothed barge to bow transition	2.4.1	Small coupled convoy
	Shortening of aft-ship gondolas	2.4.2	Rhine vessel 110m
Alternative rudders	Twin NACA rudders	2.5.1	Canal push boat
	Twin NACA rudders	2.5.2	Rhine vessel 110m

What did MoVe IT! do? …

WP2 started with a consolidated inventory of suited retrofit improvement measures in terms of a desk study. A ranking was enabled by weighting the improvement with the (financial) effort, such that little improvements for little efforts rank similar with expensive measures that provides in relation to their efforts equivalent improvements.

From the this way highest ranking measures a selection that fits to the MoVe IT! test ships was surveyed in detail resulting in the cases 2.2.1 to 2.5.2 as summarised in the table to the left. This does not mean that improvement measures that are not explicitly dealt with could not case wise be beneficial and should be discussed with the contacts directly.

2.2

Propeller upgrade

Problem definition:

Propellers of inland ships are rather small as they are restricted to the top by free water surface with possible risk of ventilation and downwards by the vessels draught at restricted water depth. Additionally, depending on the water depth the vessel is sailing, the ship's resistance is very high due to shallow water effects. Therefore propellers of inland sailing ships have to produce a relatively large thrust with at the same time restricted propeller size. This results in a high propeller loading. Under this condition the efficiency of ship propellers is rather low. All (retrofit-able) measures that either reduce the ship's resistance or result in a higher propulsive efficiency could be seen beneficial as long as other restricting boundary conditions -such as clearances to hull and freedom from ventilation- are coped with.

Proposed solution: Propeller Upgrade

Application of a nozzle around the propeller increases the propulsive thrust and often leads to a higher propulsive efficiency. But the space demand of the nozzle is reducing the propeller size such that nozzles are not a general mitigation measure.

The problem of propeller ventilation -with and without nozzles- is also requiring a careful and case wise check of this improvement measure.

What did MoVe IT! do?

• • •

There is ample knowledge on state of the art propulsion techniques such that MoVe IT! concentrated on rather new ideas and developments such as the Pump Propeller as brought in and surveyed by MoVe IT! partner Masson Marine / Ship Studio.

The improvement potential of new propeller designs and arrangements were integrally surveyed based on computed, measured or provided figures with input from work package "Hydrodynamic improvements" and work package "System Integration".

Two ships were selected as appropriate candidates and presented as case 2.2.1 and 2.2.2.

Propeller replacement “Pump Propeller”

Ship-owner Plimsoll (H) about

Herso-1

“Poor performance as single unit”

Investigations:

- Full-scale measurements
- Propeller redesign
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- MARIN
- DST
- Masson Marine / Ship Studio
- TU Delft
- Ecorys
- University of Budapest

Prime effect: increased propulsive efficiency

Motor cargo vessel (CEMT IV): L85m x B9.5m - 1380 ton

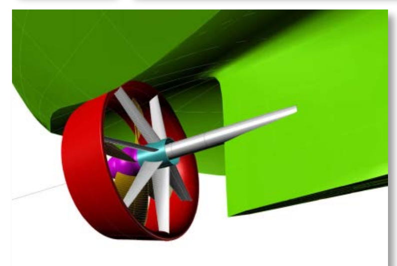
Key factors		
+	*Short down time*	
+	***Modifications are small***	
-	*More vulnerable to flotsam*	

Effects
Reduced fuel consumption with 12%
12% less emissions (CO_2, NO_x, PM)
Less vibrations

Suitable solution for any inland ship

Investment	
Equipment	*95,000 €*
Conversion	*15,000 €*
Downtime	*1 week*

Economics	
Payback period	***4 – 6 years***
Nett present value (x1000 €)	*180 - 200*
Internal rate of return	*20% - 30%*



2.2.1 Propeller replacement "Pump Propeller"

Description of the retrofit option

The existing ducted propeller will be replaced by a tailor-designed stator-rotor system called "Pump Propeller", leading to savings of 12% in required propulsion power.

Background of the MoVe IT! business case

The Herso-1 sails on Upper and Middle Danube between Budapest and Regensburg. Purchase and fuel costs are based on Western-European prize level; Labour and conversion costs, yard and docking costs are based on Eastern-European level.

Technical feasibility, technological maturity

The called "Pump Propeller" is an available product. Its characteristics were determined by intensive CFD calculations and model tests. The "Pump Propeller" was successfully applied to a fish trawler.

Bandwidth of the gains/investments and effects

A sensitivity analysis has been performed, in which investments are varied (+20% / -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Enabling conditions and boundaries

The best results are obtained for stable hydrodynamic inflow conditions. In other words: the "Pump Propeller" is best suitable for rather favourable water depths.

Which actions to be taken

An engineering bureau or an experienced ship yard is to be contacted to estimate the amount of work and to plan the building activities. In the estimation of the hydrodynamic properties a propeller expert is to be included.

Applicability to other ship types

The "Pump Propeller" is applicable to any inland ship type. However, the stator vanes are more vulnerable to flotsam and stones than conventional propeller blades.

More Information

MoVe-IT! Deliverable 2.1 — 2.2 on Hydrodynamics
MoVe-IT! Deliverable 7.1 — 7.3 on System Integration

Contact: Dr.-Ing. Cornel Thill, DST, +49 (0)203 99 369 20

2.2.2

Propeller replacement "Pump Propeller"

Compagnie Fluviale Transport - CFT (F) about

"Inflexible"

"Fuel efficiency could be a bit higher…"

Investigations:

- Full-scale measurements
- Propeller redesign
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- MARIN
- DST
- Masson Marine / Ship Studio
- TU Delft
- Ecorys
- University of Budapest

Prime effect: 10% - 15% reduction of fuel consumption

Canal Push Boat (CEMT IV-V): L 22.20m x B 9.45m + 2 EII barges

Key factors		
+	Short down time	
+	Modifications are small	
-	More vulnerable to flotsam	

Effects
Reduced fuel consumption with 12%
12% less emissions (CO_2, NO_x, PM)
Less vibrations

Suitable solution for any inland ship

Investment	
Equipment	230,000 €
Conversion	30,000 €
Downtime	1 week

Economics	
Payback period	5 years
Nett present value (x1000 €)	280 – 350
Internal rate of return	17 –23%

2.2.2

Propeller replacement "Pump Propeller"

MoVe IT!

SEVENTH FRAMEWORK PROGRAMME

Description of the retrofit option

The existing ducted propeller will be replaced by a tailor-designed stator-rotor system called "Pump Propeller", leading to savings of 12% in required propulsion power.

Background of the MoVe IT! business case

MV Inflexible sails on the Seine between L'Havre and Paris. Purchase and fuel costs are based on West-European prize level; also for labour and conversion costs, yard and docking costs.

Technical feasibility, technological maturity

The called "Pump Propeller" is an available product. Its characteristics were determined by intensive CFD calculations and model tests. The "Pump Propeller" was succesfully applied to a fish trawler.

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A sensitivity analysis has been performed, in which investments are varied (+20% / -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

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More Information

MoVe-IT! Deliverable 2.1 — 2.2 on Hydrodynamics
MoVe-IT! Deliverable 7.1 — 7.3 on System Integration

Contact: Dr.-Ing. Cornel Thill, DST, +49 (0)203 99 369 20

Improved propeller inflow

Problem definition:

Appendages in front of the propeller can affect the inflow negatively in a way that possibly only less efficient propellers can be designed. Many of these appendices are designed and applied for good reasons but may be worthwhile to be reconsidered with the aim to improve the performance of ships or pushboats.

Proposed solution: Improvement of propeller inflow

Removal of flanking rudders can improve the propulsive efficiency of push boats by 10 to 15 per cent. However, the transverse force that is produced by the flanking rudders during backing and stopping manoeuvers has to be generated alternatively: e.g. with transversal (bow or stern) thrusters.

Removal of nozzle struts or shaft brackets in front of the propeller can improve the propulsive efficiency of inland ships and push boats by about 5%. The structural behaviour (strength and vibrations) is to be checked of nozzle and propeller shaft with less supports.

What did MoVe IT! do?

• • •

CFD calculations are a proper means to survey the effect of shape modifications of complete hulls but also for studying details of the design such as appendages.

With proper modelling of the propellers either by actuator disk models or by detailed rotating propeller geometries even the judgement of inflow of the working propeller while (i.e. effective wake) instead of judging it based on measurements without working propeller (i.e. nominal wake) is feasible.

MoVe IT! investigated cases 2.3.1, 2.3.2, 2.4.1 and 2.4.2 with CFD.

2.3.1

Flanking rudder removal (+ bowthruster)

Ship-owner Helogistics (H) about

Dunavöldvar

"… not enough power to push 6 barges"

Investigations:

- Full-scale measurements
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- MARIN
- DST
- TU Delft
- Ecorys
- University of Budapest

Prime effect: 5% - 10% higher propulsive efficiency

Ship type (CEMT VI): L37.50m x B12.54m + 4-6 DEII barges (4-6x 1800 ton)

Key factors

+	*Suitable bow form for bow thruster*
+	No further conversions needed for propeller and nozzles
-	Substancial conversion activity

Effects

- *Lower fuel consumption of 5% - 10%*
- *Lower emissions*
- *Improved manoeuvrability*

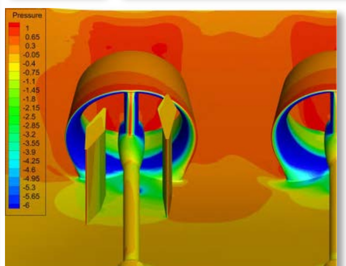
Suitable solution for push boats with flanking rudders

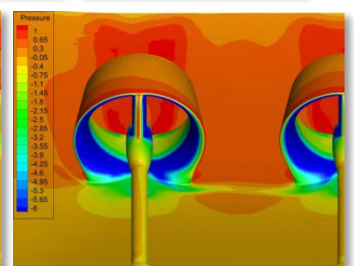
Investment

Equipment	*200,000 €*
Conversion	*65,000 €*
Downtime	*3 weeks*

Economics

Payback period	*4 years*
Nett present value (x1000 €)	*600*
Internal rate of return	*30%*





2.3.1 Flanking rudder removal (+ bowthruster)

Description of the retrofit option

Flanking rudders ahead of the outer propellers are removed. The transverse force needed in backing and manoeuvring conditions is generated by a bow thruster.

Technical feasibility, technological maturity

Nowadays pushboats are designed to operate without flanking rudders. Multiple Rhine push boats are modernized this way. This option is technologically mature.

Enabling conditions and boundaries

The bow form must provide enough space to accommodate a bow thruster gondola. The hydrostatics of the modified ship has to be checked as the trim influences efficiency negatively.

Applicability to other ship types

This measure is suitable for push boats that are fitted out with flanking rudders.

Background of the MoVe IT business case

The Dunavöldvar sails on the Middle and Lower Danube between Izmail and Budapest. Purchase and fuel costs are based on West-European prize level; Labour and conversion costs, yard and docking costs on Eastern-European level.

Bandwidth of the gains/investments and effects

A sensitivity analysis has been performed, in which investments are varied (+20% / -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Which actions to be taken

An engineering bureau or an experienced ship yard is to be contacted to estimate the amount of work and to plan the building activities. In the estimation of the required transversal thrust an expert in hydrodynamics is to be included.

More Information

MoVe-IT! Deliverable 2.1 — 2.2 on Hydrodynamics
MoVe-IT! Deliverable 7.1 — 7.3 on System Integration

Contact: Dr.-Ing. Cornel Thill, DST, +49 (0)203 99 369 20

2.3.2 Nozzle strut removal

Compagnie Fluviale Transport - CFT (F) about

"Inflexible"

"Fuel efficiency could be a bit higher…"

Investigations:

- Full-scale measurements
- CFD and FE calculations
- Design integration
- Economic assessment

Involved partners:

- MARIN
- DST
- Masson Marine / Ship Studio
- TU Delft
- Ecorys
- TNO
- University of Budapest

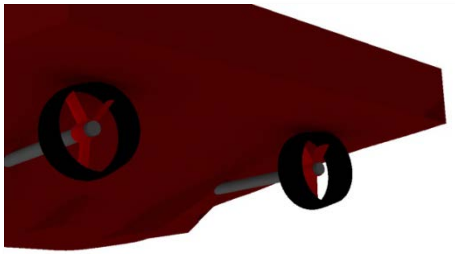
Prime effect: increased propulsive efficiency

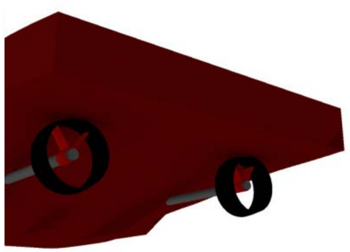
Canal Push Boat (CEMT IV-V): L 22.20m x B 9.45m + 2 EII barges

Key factors			Effects
	+	n/a	5% reduction of fuel consumption
			5% Lower emissions
	-	n/a	Less vibrations

Suitable solution for vessels with supported nozzles

Investment			Economics	
	Equipment	0 €	Payback period	11 years
	Conversion	70,000 €	Nett present value (x1000 €)	75
	Downtime	4 weeks	Internal rate of return	10 –15%





Nozzle strut removal

Description of the retrofit option
The three original struts in the nozzle will be removed and replaced by a cast one in order to improve the inflow to the propellers. An improvement of the propulsion efficiency of 5% is expected.

Background of the MoVe IT! business case
The Inflexible sails on the Seine between L'Havre and Paris. Purchase and fuel costs are based on West-European prize level; also for labour and conversion costs, yard and docking costs.

Technical feasibility, technological maturity
Nowadays nozzles are constructed in such a way that struts are just a necessary evil. Wherever constructive possible struts should be avoided (if not having a hydrodynamic function such as a stator)

Bandwidth of the gains/investments and effects
Effects on fuel consumption and emissions of 5% (+/-1%) Investment depends on yard activities. If strut removal only is technically feasible then investment about 35,000 € per propeller.

Enabling conditions and boundaries
The nozzle itself should be required from a hydrodynamic point of view and its construction should be stiff enough to function without struts.

Which actions to be taken
The structural dynamics of the propeller shaft has to be checked by an expert engineer. An expert estimation of the expectable hydrodynamic improvements is advisory.

Applicability to other ship types
Principally this measure is applicable to any inland ship type if the nozzle is fitted out with multiple struts.

More Information
Please read MoVe-IT! Deliverables 7.1 and 7.2.

Contact: DST: +49 - 203-99 369 40

Hull shape optimisation

Problem definition:

Faired hull lines form the basis for an energy efficient ship design. Shape optimisation with e.g. Computational Fluid Dynamic methods or model tests can lower the ship's resistance substantially. In the design phase, hull shape optimisation can be carried out with limited effort.

Proposed solution: CFD calculations of hull and hull details

For existing ships, however, hull shape modification is rather cumbersome due to limited space and the presence of accommodation, tanks, machinery and equipment. Further is to be considered that hull modifications can only be conducted if the ship is dry-docked. This implies that the vessel is out of service for a longer period.

Nevertheless, the potential of CFD can be exploited for restricted areas (such as gondolas and appendages) or when little structural modifications are required (e.g. when adding displacement outside the existing hull).

What did MoVe IT! do?

• • •

As CFD calculations are a proper means to survey the effect of shape modifications of complete hulls in the design process, MoVe IT! surveyed possibilities to exploit their benefit for existing ships. It turned out that application of CFD to the whole hull is having no economic potential, even when distinct design strategies (such as creating additional displacement onto the existing hull) are applied.

MoVe IT!, therefore, investigated cases 2.4.1 and 2.4.2 with CFD where the envisaged form modifications are feasibly restricted to distinct regions.

2.4.1

Smoothed barge-to-bow transition

Ship-owner Plimsoll (H) about

Herso-1

"Poor performance when pushing a barge"

Investigations:

- Full-scale measurements
- CFD calculations
- Model tests
- Design integration
- Economic assessment

Involved partners:

- MARIN
- DST
- TU Delft
- Ecorys
- University of Budapest

Prime effect: 7% - 11% reduction of fuel consumption

Coupled convoy (CEMT IV): L85m x B9.5m + L70m x B11.0m

Key factors		
+	*Proven technology*	
+	*Short down time*	
-	*Increased vessel length*	

Effects
Lower fuel consumption
Lower transport costs
Less emissions

Suitable solution for any coupled convoy

Investment	
Equipment	*25,000 €*
Conversion	*75,000 €*
Downtime	*2 weeks*

Economics	
Payback period	*4 – 6 years*
Nett present value (x1000 €)	*180 – 200*
Internal rate of return	*22 – 31%*

Smoothed barge-to-bow transition

Description of the retrofit option
The pushed barge is equipped with two extensions that fill-up the gap between the barge stern and the bow of the pushing vessel.

Technical feasibility, technological maturity
The proposed modernisation option is proven technology: several coupled convoys are equipped with such a connection.

Enabling conditions and boundaries
Application to areas with no sensitive superstructure and to spatially restricted parts of the hull. Alternatively, on built or additional structures (e.g. transition piece) are potential candidates.

Applicability to other ship types
The measure of a transition piece is generally appli-cable to coupled convoys that often sail with a barge but also need the flexibility to sail without. The improved connection reduces the interchangeability of barges.

Background of the MoVe IT! business case
The coupled convoy Herso-1 / Leonie sails on the Upper and Middle Danube between Regensburg and Budapest. Purchase and fuel costs are based on West-European prize level; Labour and conversion costs, yard and docking costs on Eastern-European level.

Bandwidth of the gains/investments and effects
A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Which actions to be taken
An engineering bureau or an experienced ship yard should be contacted to design, construct and build the transition pieces.

More Information
Please read MoVe-IT! Deliverable 2.2, 7.1 and 7.3.

Contact: Dr.-Ing. Cornel Thill, DST, +49 (0)203 99 369 20

2.4.2

Shortening of aft-ship gondolas

Carpe Diem Inland Shipping (NL) about

"Carpe Diem"

"Emissions have to be reduced"

Investigations:

- Full-scale measurements
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- MARIN
- Autena Marine
- VNF
- DST

Prime effect: Some reduction in fuel consumption

Large Rhine Vessel (CEMT Va): L110m x B11.45m – 3000 ton or 153 TEU

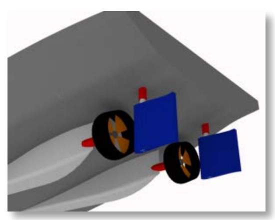
Key factors		
+		
+		
-		

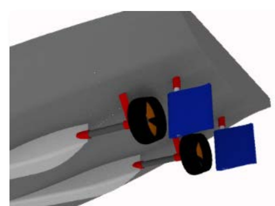
Effects
0% - 3% reduced fuel consumption

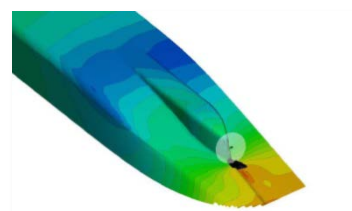
Suitable solution for vessels with skegs or gondolas

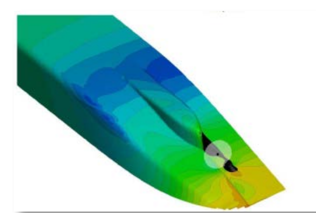
Investment	
Equipment	10,000 €
Conversion	150,000 €
Downtime	4 weeks

Economics	
Payback period	> 25 years
Nett present value (x1000 €)	–105
Internal rate of return	–4%









Shortening of aft-ship gondolas

Description of the retrofit option

The gondolas in the aftship are not well aligned with the flow, which results in extra resistance and fluctuations in the wake field. Partly removing the gondolas will reduce both resistance and fluctuations.

Technical feasibility, technological maturity

The proposed modernisation option is proven technology; several inland vessels are equipped with open shaft arrangements.

Enabling conditions and boundaries

When removing parts of the gondolas special attention needs to be paid to the support of the shaft axes, so their strength is sufficient and everything is well aligned with the flow.

Applicability to other ship types

In principal this measure is applicable to any inland ship type with a twin gondola aftship.

Background of the MoVe IT! business case

The Carpe Diem sails regularly between Rotterdam and the Northern Netherlands. Purchase and fuel costs are based on West-European prize level; also for labour and conversion costs, yard and docking costs.

Bandwidth of the gains/investments and effects

A sensitivity analysis has been performed, in which investments are varied (+20% / -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Which actions to be taken

Only very experienced engineering bureaus or ship yard, possibly supported by a ship model basin should be contacted to design, construct and build the new gondolas.

More information

Please read MoVe-It Deliverables 7.1 – 7.2

Contact Mrs. Karola v/d Meij, MARIN, +31 317 49 39 11

or Dr.-Ing. Cornel Thill, DST, +49 (0)203 99 369 20

2.5

Alternative rudder configuration

Problem definition:

Moderate increase in propulsion efficiency can be derived by application of alternative rudder configurations. The number of rudder blades, their size and their position in the propeller outflow determine the amount of thrust losses. On the other hand, the manoeuvrability of the ship has to be ascertained under multiple navigation conditions.

A well-designed rudder configuration combines proper manoeuvrability with small thrust losses. Which configuration suits best, depends on the operational profile of the ship.

Investigated solutions:

Model test results on the influence of different rudder configurations on the power performance of a large Rhine ship were investigated. Based on that the configurations were indicated as promising retrofit solutions. However, due to differences in manoeuvrability, the maximal gain in propulsive performance was not assured. Due to the rather small reduction in fuel consumption, in these particular cases the benefit of this investments did not weigh the costs.

What did MoVe IT! do?

• • •

As results form model tests indicated significant effect of alternative rudder configurations, MoVe IT! surveyed possibilities to exploit the benefit of these configurations if applied to existing ships. It turned out that for the investigated cases in MoVe IT! NO financial benefit was gained by application of alternative rudder configurations.

MoVe IT!, therefore, investigated cases 2.5.1 and 2.5.2 keeping in mind that the configurations may have different manoeuvring performances .

2.5.1

Alternative rudder concepts

Compagnie Fluviale Transport - CFT (F) about

"Inflexible"

"Fuel efficiency and Manoeuvrability could be better..."

Investigations:

- Full-scale measurements
- System integration
- Economic assessment

Involved partners:

- MARIN
- Autena Marine
- VNF
- DST

Prime effect: Slight improvement of propulsive efficiency

Canal Push Boat (CEMT IV-V): L 22.20m x B 9.45m + 2 EII barges

Key factors		
+		
+		
-		

Effects
3% - 4% reduced fuel consumption
Small reduction in emissions
Better manoeuvrability

Suitable solution for inland vessels with similar rudder configurations

Investment	
Equipment	120,000 €
Conversion	100,000 €
Downtime	2 weeks

Economics	
Payback period	>25 years
Nett present value (x1000 €)	– 100
Internal rate of return	0%

2.5.1

Alternative rudder concepts

Description of the retrofit option

The two straight rudders are replaced by two slender twin rudders with NACA profile sections.

Background of the MoVe IT! business case

The Inflexible sails on the Seine between L'Havre and Paris. Purchase and fuel costs are based on West-European prize level; also for labour and conversion costs, yard and docking costs.

Technical feasibility, technological maturity

These rudder solutions can be considered as technically mature and can be purchased as available products.

Bandwidth of the gains/investments and effects

A sensitivity analysis has been performed, in which investment are varied (+20% / -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Enabling conditions and boundaries

The lateral force increase imposed or envisaged by the Fishtail Rudder should not be required from manoeuvring point of view or should be enabled by other envisaged modifications such as thrusters.

Which actions to be taken

Only experienced engineering bureaus or rudder manufacturers, possibly supported by a ship model basin should be contacted to design, construct and build the new rudders.

Applicability to other ship types

In principal this measure is applicable to any inland ship type if rudders with a high individual resistance are applied (either in the slipstream of the propeller or in "natural" inflow of the ship).

More information

Please read MoVe-It Deliverables 7.1 – 7.3

Contact Mrs. Karola v/d Meij, MARIN, +31- 317 49 39 11

2.5.2

Alternative rudder concepts

Carpe Diem Inland Shipping (NL) about

"Carpe Diem"

"… even a good ship can still have potential"

Investigations:

- Full-scale measurements
- Model tests
- System integration
- Economic assessment

Involved partners:

- MARIN
- Autena Marine
- TUDelft
- DST

Prime effect: Improvement of propulsive efficiency

Large Rhine Vessel (CEMT Va): L110m x B11.45m – 3000 ton or 153 TEU

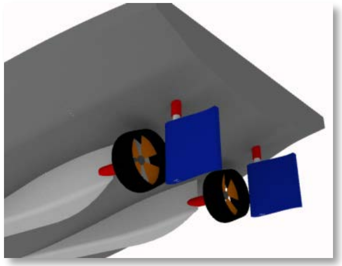
Key factors	
+	
+	
-	

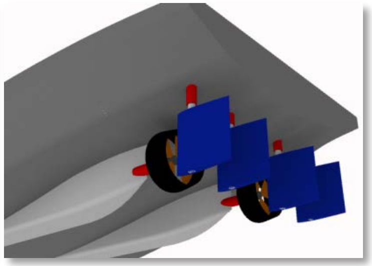
Effects
3% - 4% reduced fuel consumption
Small reduction in emissions

Suitable solution for inland vessels with similar rudder configurations

Investment	
Equipment	120,000 €
Conversion	100,000 €
Downtime	2 weeks

Economics	
Payback period	> 25 years
Nett present value (x1000 €)	-127
Internal rate of return	–2%





2.5.2

Alternative rudder concepts

Description of the retrofit option

The two so-called Fishtail Rudders are replaced by two slender twin rudders with NACA profile sections.

Technical feasibility, technological maturity

These rudder solutions can be considered as technically mature and can be purchased as available products.

Enabling conditions and boundaries

The lateral force increase imposed or envisaged by the Fishtail Rudder should not be required from manoeuvring point of view or should be enabled by other envisaged modifications such as thrusters.

Applicability to other ship types

In principal this measure is applicable to any inland ship type if Fishtail Rudders are applied.

Background of the MoVe IT! business case

The Carpe Diem sails regularly between Rotterdam and the Northern Netherlands. Purchase and fuel costs are based on West-European prize level; also for labour and conversion costs, yard and docking costs.

Bandwidth of the gains/investments and effects

A sensitivity analysis has been performed, in which investments are varied (+20% / -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2.

Which actions to be taken

Only experienced engineering bureaus or rudder manufacturers, possibly supported by a ship model basin should be contacted to design, construct and build the new rudders.

More information

Please read MoVe-It Deliverables 7.1 – 7.3

Contact Mrs. Karola v/d Meij, MARIN, +31- 317 49 39 11

Lessons Learned

Lesson 1: "Increasing the performance of an existing inland ship is not easy"

Almost every modification of an existing inland ship will eventually have a hydrodynamic consequence. Replacing the engine might affect trim and sinkage due to a different weight. When not holistically taken into account, intended benefits may not be reached and investments made may not pay back. Without case wise judgement by designated experts, many "fool proof" improvement measures could result in (complete) disasters.

Lesson 2: "The best retrofit-able solution might be very different from the best thinkable solution for a new built vessel"

Retrofitting differs essentially from design from scratch. The existing ship including the underlying design philosophy must be understood as otherwise the best intentions can completely revert into their opposite. Initial investments and life-time costs (over the rest of the life-span of the vessel) need to be considered.

Lesson 3: "System integration in the design stage is much more effective, but system integration within a retrofit improvement measure is still of paramount importance"

As everything is linked with surprisingly many other features of an existing vessel -in particular interlinked by the hydrodynamics of the design- little improvements can be outbalanced by disadvantages imposed by the same measure on other features. System integration techniques -in particular when applied by experienced experts- can help to reduce this risk.

Colofon

For more information about Hydrodynamic Improvement

Please contact:

Dr.-Ing. Cornel Thill
Department Special Research and Innovation

DST - Development Centre for Ship Technology and Transport Systems
P.O. Box 10 13 49
47013 Duisburg
Germany

T: +49 (0)203 99 369 20
F: +49 (0)203 36 13 73
E: thill@dst-org.de

For more information about the collaborative project or one of the work packages

Please contact:
Project Leader MoVe IT!

Mr. Meeuwis van Wirdum
MARIN – Team IWT
Project Coordinator

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 39 11
E: inlandship@marin.nl

www.moveit-fp7.eu

These guidelines are part of Move IT! dissemination

The guidelines are created by Erwin van Heumen, DST, on the basis of the work realised in the project.

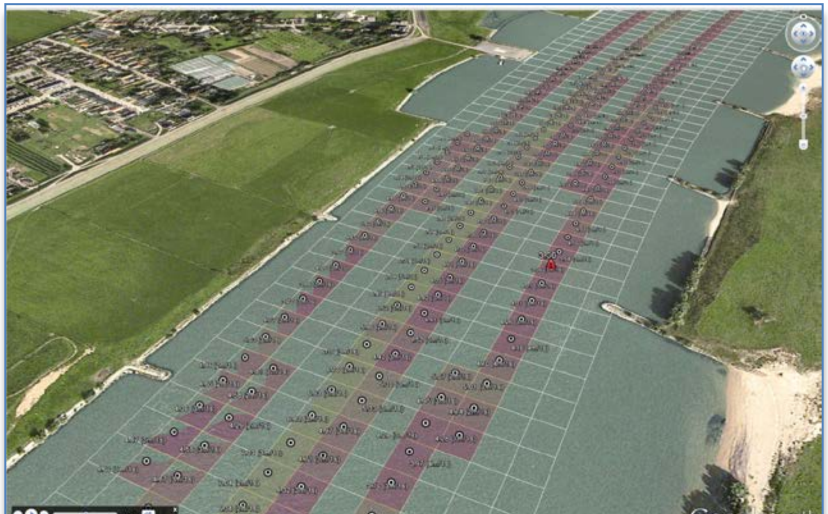
Please contact:

DST - Development Centre for Ship Technology and Transport Systems
Department Transport Systems
T: +49 (0)203 99 369 -51
E: scholten@dst-org.de
P.O. Box 10 13 49
47013 Duisburg
Germany

Stichting Projecten Binnenvaart (SPB) lead Move-It! dissemination. For questions on dissemination you can contact SPB through the project coordinator or directly via: b.kelderman@binnenvaart.nl

Guidelines on Modernisation of Inland Ships

In order to improve inland waterway freight transport to the standards of tomorrow, inland shipping needs to MoVe IT!



August 2014
MoVe-It Consortium
http://www.moveit-fp7.eu/

		Booklet
	General Guidelines	*1*
Themes	*Hydrodynamic Improvement*	*2*
	Efficient ship operation	***3***
	Powering and Engines	*4*
	Ship Structures & Weight	*5*
	New Scales and Services	*6*

“In order to improve inland waterway transport to the standards of tomorrow, inland shipping needs to MoVe IT!”

- Meeuwis van Wirdum – Project leader -

Objective of this guidelines

•••

MoVeIT! is a European research project, in which a set of options is developed for the modernisation of inland ships that meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

Efficient Ship Operation

•••

One of the main focal points of MoVe IT! is the application of Measuring Equipment onboard of inland ships in order to monitor the operational profile and to collect available water depths. Further, the ship operation can be made more efficient by using an EconomyPlanner software. This small investment enables durably fuel savings.

What’s MoVe-It?

•••

Strengthening the future of existing IWT vessels by investigating retrofit options from both a technical and an economical perspective. MoVeIT! is a European research project. The project closely looks into vessels and their performance and develops a set of viable options for modernisation. These options will allow these vessels to meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

One of the main focal points of MoVe IT! is the modernisation of the ship´s drive and power system in a way that is matched to the conditions it will face throughout its life. This will result in significantly better performance compared to the ships old systems that are designed to fulfil a single design condition.

Contents

"Efficient operating can increase the performance by sailing the optimal speed!"

How to read this guidelines?

•••

In the following sections explain you how the performance of inland ships can be improved without large investment in hardware but by optimising the way your ship is operated. The brief descriptions of the investigated solutions only present the core results of the project as descision aid. Detailed information however can be found in the Deliverables 3.1 — 3.4 on the MoVe IT! Website.

Introduction

Problem definition:

Restrictions in water depth and width are important factors in the energy consumption of inland vessels. In confined waters the propeller hull interaction becomes less favorable resulting in a reduced propeller efficiency and therefore in increased fuel consumption. Real time and future water depth information are not always available for the European rivers.

Proposed solution: Economy Planner

One of the main goals of the EconomyPlanner is to create a real time local water depth chart based on cooperative navigable depth measurements, which will be the basis of other functionalities of the EconomyPlanner like the determination of the optimal track and maximum allowable cargo capacity.

Since restrictions in water depth have a negative effect on the fuel consumption, the Virtual Ship module of the EconomyPlanner will look for the deepest part of a river for a given route, taken into account the manoeuvring characteristics of the vessel. In order to determine the optimal track not only real time water depths are needed, but also the expected water depths along the entire route and during the entire voyage.

Furthermore, the maximum allowable loading condition can be determined for a voyage based on real time and future water depth information .

What did MoVeIT! do? …

The echo-sounder, loading gauges and GPS already present onboard an inland vessel are linked to one another via a compact device of the EconomyPlanner. Each second this device gathers data from these sensors and every hour this collected data will be forwarded to an onshore server.

Together within the European MoVeIT! project and the Dutch Covadem project about 40 inland vessels, navigating the European inland waterways, are equipped with the EconomyPlanner and continuously sharing water depth information. These data is used for the generation of a real time local water depth chart.

3.2

EconomyPlanner

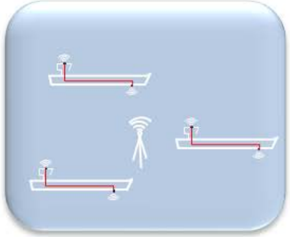
"Fuel costs form substantial part of operational costs"

Investigations:

- Full-scale measurements
- Application of GPS and water depth sensors
- Statistical analysis of water data

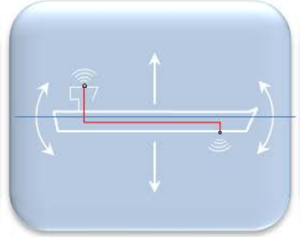
Involved partners:

- MARIN
- Autena Marine
- DST
- Via Donau
- VNF
- CfT
- Helogistics
- Plimsoll
- ThyssenKrupp Veerhaven

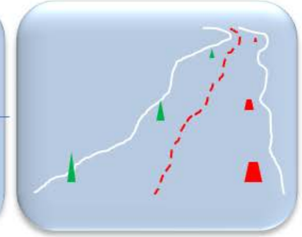


Cooperative Real time Depth Information

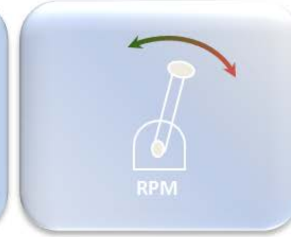
Intelligent Water Level Prediction



Advanced Trim & Squat Calculation

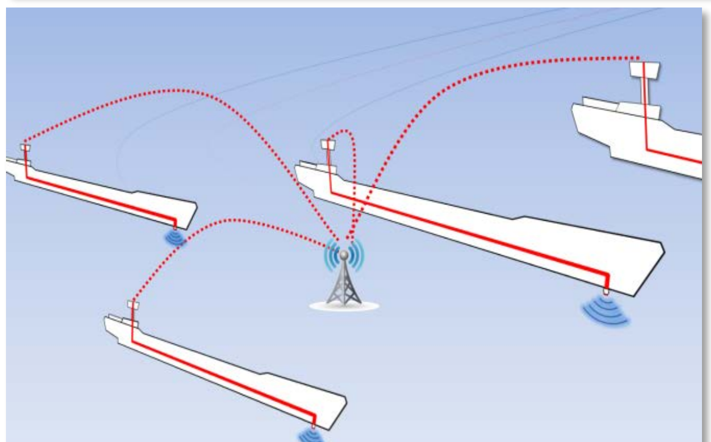


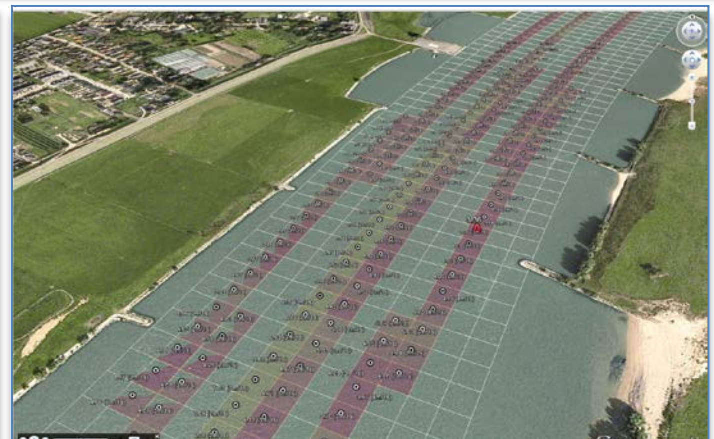
Optimal Track determination



Efficient Engine Setting

More Cargo – Less Fuel – Less Emission – More Reliable





3.2 EconomyPlanner

Description of the EconomyPlanner

Based on cooperative navigable depth measurements a real time local water depth chart is generated which is the basis of other functionalities like the determination of the optimal track and maximum allowable cargo capacity.

Background of the MoVe IT business case

Without changes in the ship itself the EconomyPlanner provides an opportunity to reduce fuel consumption.

Technical feasibility, technical maturity

About 40 inland vessels, navigating the European inland waterways, are equipped with the EconomyPlanner. These vessel continuously sharing water depth information.

Bandwidth of the Gains/Investments and Effects

By using the EconomyPlanner fuel consumption and emissions can be reduced and more cargo can be transported. Furthermore a more reliable voyage planning can be made.

Enabling conditions and boundaries of this option/technology

The EconomyPlanner can be used on any inland vessel having an echo-sounder, loading gauges and GPS already present onboard.

Which actions to be undertaken :

To join Covadem, please contact:

M. van Wirdum, MARIN, +31-317 49 35 59

Applicability to other ship types

Applicable to any inland ship type.

More information

Please read MoVe-It Deliverables

3.1, 3.2, 3.3, 3.4, 8.2 and 8.3

Contact A. Bons, MARIN, +31-317 49 35 33

Future developments of the EconomyPlanner

Objective 1: “Maximum allowable loading condition”

The focus for further development should be the provision of the maximum allowable loading condition for a given a route, in such a way that critical points on the route can be passed. This will be the first added value for ship owners.

Objective 2: “Validation”

The main focus of the development of the EconomyPlanner is on the provision of real time river depths, which needs to be further validated on accuracy and availability. This is important to realize before further developments of other EconomyPlanner functionalities can be done efficiently. It should be emphasized that it would be already a great improvement if the EconomyPlanner provides real time water depth information along the entire route and entire voyage of vessels using the European inland waterways, with at least the same accuracy as the currently available water depth information.

“Covadem”

The Covadem project (cooperative navigable depth measurements – Coöperatieve vaardieptemetingen) was launched in April 2013 based on the results of MoVeIT! and the Dutch government funded project IDVV. The project is aimed at sharing current navigable depth measurements, with the help of which shipmasters will be able to navigate more efficiently in future and make maximum use of the navigable area provided by the waterway.

Lessons learned

Lesson 1: “Navigation conditions have large impact on fuel consumption”

Information on detailed local navigation conditions, comprising water depth, river width and stream velocities is considered as important basis for proper conduction of vessel performance calculations and economic sailing.

Lesson 2: “Follow training courses to improve your sailing behaviour”

It is beneficial to avoid high speeds at low water depths and to adjust the ship speed to the present navigation conditions (e.g. traffic density, locks on the route, current, tide, etc.)
Several training courses are being provided that learn you how to reduce the fuel consumption by means of changing your sailing behaviour, like for example:

“VoortVarendBesparen” (EICB & STC)
Training course for skippers with the aim to reduce fuel consumption by creating awareness and usage of planning tools.

“Topofahrt” (DST)
Reduction of fuel consumption and exhaust gas emissions of inland ships by “topography-oriented” sailing. Training concept for skippers with the use of full mission simulators.

Colophon

For more information about Efficient ship operation

Please contact:

Arno Bons MSc.
MARIN – Maritime Simulation & Software Group
Project Manager

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 34 72
E: A.Bons@marin.nl

For more information about the collaborative project or one of the work packages

Please contact:
Project Leader MoVe IT!

Mr. Meeuwis van Wirdum
MARIN – Team IWT
Project Coordinator

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 39 11
E: inlandship@marin.nl

www.moveit-fp7.eu

These guidelines are part of Move IT! dissemination

The guidelines are created by Erwin van Heumen, DST, on the basis of the work realised in the project.

Please contact:

DST - Development Centre for Ship Technology and Transport Systems
Department Transport Systems
T: +49 (0)203 99 369 -51
E: scholten@dst-org.de
P.O. Box 10 13 49
47013 Duisburg
Germany

Stichting Projecten Binnenvaart (SPB) lead Move-It dissemination. For questions on dissemination you can contact SPB through the project coordinator or directly via: b.kelderman@binnenvaart.nl

Guidelines on Modernisation of Inland Ships

In order to improve inland waterway freight transport to the standards of tomorrow, inland shipping needs to MoVe IT!

August 2014
MoVe-It Consortium
http://www.moveit-fp7.eu/

Themes		Booklet
	General Guidelines	1
	Hydrodynamic Improvement	2
	Efficient ship operation	3
	Powering and Engines	4
	Ship Structures & Weight	5
	New Scales and Services	6

Preface

“In order to improve inland waterway transport to the standards of tomorrow, inland shipping needs to MoVe IT!”

- Meeuwis van Wirdum – Project leader -

What’s MoVe-It?

•••

Strengthening the future of existing IWT vessels by investigating retrofit options from both a technical and an economical perspective. MoVeIT! is a European research project. The project closely looks into vessels and their performance and develops a set of viable options for modernisation. These options will allow these vessels to meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

One of the main focal points of MoVe IT! is the modernisation of the ship´s drive and power system in a way that is matched to the conditions it will face throughout its life. This will result in significantly better performance compared to the ships old systems that are designed to fulfil a single design condition.

Objective of this guidelines

•••

MoVeIT! is a European research project, in which a set of options is developed for the modernisation of inland ships that meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

Engine replacement and after treatment

•••

One of the main focal points of MoVe IT! is the modernisation of the ship´s power system in a way that is matched to the conditions it will face throughout its life. Renewal of existing engines is a suitable retrofit option in order to comply with current emission standards. Depending on the existing engine system, the investement can be possibly earned back. However, the payback period may be long.In order to comply with much stricter emission standards than the current ones, catalysts and/or filters can be suitable alternatives.

Contents

"Inland ships can be made cleaner and more effective by renewing the engines or by the installation of Selective Catalytic Reduction (SCR)."

How to read this guidelines? …

The following options in terms of power generation can be applied as retrofitting option. The selected case studies demonstrate the technical and economical feasibility of the solutions as descision aid. Detailed information however can be found in the Deliverables 4.1 — 4.3 and 7.1 — 7.3 on the MoVe IT! Website.

Introduction

Problem definition:

In the near future, owners and operators of inland water way vessels will have to deal with more limiting regulations with regards to air polutant emissions of combustion engines.

Investigated solutions:

During the course of the project, a variety of different retrofit solutions for improving the economic and environmental performance of inland waterway ships were identified and investigated. Three techniques were identified as promising refit options: Diesel engine renewal; installation of selective catalytic reduction (SCR) and waste heat recovery. The following table gives an overview of refit option, their application to the reference ships and indication of the technical and economic feasibility of the measures.

	Modification options	Case	Ship type
Engine renewal	Diesel engine renewal	4.2.1	Danube push boat (9 barges)
Engine renewal	Diesel engine renewal	4.2.2	Danube push boat (6 barges)
After treatment	Selective Catalytic Reduction	4.3.1	Rhine push boat
Other	Waste heat recovery	4.4.1	Canal push boat

What did MoVe IT! do?

The general target within this task was to identify and investigate technical solutions to reduce air polutant emissions with respect to the power generation on board of inland ships.

Five reference ships were selected and equiped with measurement equipment to measure the fuel consumption.

For three push boats, which are being operated on different operational areas namely the Rhine, the Danube and the Seine, retrofit options were investigated with respect to technical and economic feasibility.

4.2.1 Diesel engine renewal (9 barges)

Ship-owner Helogistics (H) about

Dunavöldvar

"... not enough power to push 9 barges"

Investigations:

- Full-scale measurements
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- TU Delft
- MARIN
- DST
- viadonau
- Ecorys
- University of Budapest

Prime effect: new engine delivering power to push 9 barges

Ship type (CEMT VI): L 37.50 m x B 12.54 m + 9 DEII barges (9 x 1800 ton)

Key factors		
+	Increased payload	
+	Danube allows 9 barges	
-		

Effects
Increased fuel efficiency of 15%
Increased payload of 50%
Increased transport performance

Suitable solution for any type of inland vessels

Investment	
Equipment	1,500,000 €
Conversion	250,000 €
Downtime	6 weeks

Economics	
Payback period	3 – 4 years
Nett present value (x1000€)	5,500
Internal rate of return	45%

4.2.1 Diesel engine renewal (9 barges)

Description of the retrofit option

All thee main engines are replaced by new ones. The complete drive train comprising gear boxes, propellers and nozzles are renewed. The engines are stronger than the original ones and propellers are designed for delevering enough thrust to push 9 barges.

Background of the MoVe IT business case

The Dunavöldvar sails on the Middle and Lower Danube between Izmail and Budapest. Purchase and fuel costs are based on West-European prize level; Labour and conversion costs, yard and docking costs on Eastern-European level..

Technical feasibility, technological maturity

This measure is technically feasible and mature. Renewal of main and auxilliary engines are usual shipyard activities.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Enabling conditions and boundaries

The hull and structural components of pushboat have to be in a condition that the lifetime of the push boat can be extended with 10 more years. Enough cargo should be available to obtain the required utilisation.

Which actions to be undertaken :

An engineering bureau or an experienced ship yard is to be contacted to estimate the amount of work and to plan the building activities. In the estimation of the hydrodynamic properties a propeller expert is to be included.

Applicability to other ship types

This measure on its own is suitable for any type of inland ship of which the engines are at the end of the technical lifetime. However this increase in transport performance is only possible when additional barges are pushed.

More Information:

MoVe-It Deliverable 7.1 — 7.3 on System Integration

Contact: Robert Hekkenberg, TUDelft, +31 (0)15 27 83117

Diesel engine renewal (6 barges)

Ship-owner Helogistics *(H) about*

Dunavöldvar

"… not enough power to push 6 barges"

Investigations:

- Full-scale measurements
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- TU Delft
- MARIN
- DST
- viadonau
- Ecorys
- University of Budapest

Prime effect: new engine delivering power to push 6 barges

Ship type (CEMT VI): L 37.50m x B12.54m + 6 DEII barges (6x 1800 ton)

Key factors			Effects
+			*Increased fuel efficiency of 15%*
o	*Payload increase needed*		*Emission reduction of 15%*
-	*Hydrodynamic improvement also needed*		

Suitable solution for any type of inland vessels

Investment		Economics	
Equipment	*1,500,000 €*	*Payback period*	*12 –15 years*
Conversion	*250,000 €*	*Nett present value (x1000€)*	*650*
Downtime	*6 weeks*	*Internal rate of return*	*12 –17%*

4.2.2

Diesel engine renewal (6 barges)

Description of the retrofit option

All three main engines are replaced by new ones. The complete drive train comprising gear boxes, propellers and nozzles are renewed. The propellers are designed for delevering enough thrust to push 6 barges.

Background of the MoVe IT business case

The Dunavöldvar sails on the Middle and Lower Danube between Ismail and Budapest. Purchase and fuel costs are based on West-European prize level; Labour and conversion costs, yard and docking costs on Eastern-European level..

Technical feasibility, technological maturity

This measure is technically feasible and mature. Renewal of main and auxilliary engines are usual shipyard activities.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Enabling conditions and boundaries

The hull and structural components of pushboat have to be in a condition that the lifetime of push boat can be extended with 10 more years. More important, the technical lifetime of the new engines has to be longer than the payback period (in this case 15 years).

Which actions to be undertaken :

An engineering bureau or an experienced ship yard is to be contacted to estimate the amount of work and to plan the building activities. In the estimation of the hydrodynamic properties a propeller expert is to be included.

Applicability to other ship types

This measure on its own is suitable for any type of inland ship of which the engines are at the end of the technical lifetime.

More Information:

MoVe-It Deliverable 7.1 — 7.3 on System Integration

Contact: Robert Hekkenberg, TUDelft, +31 (0)15 27 83117

Installation with SCR

Thyssen-Krupp Veerhaven (NL) about

"Veerhaven X"

"NOx Emissions have to be reduced"

Investigations:

- Full-scale measurements
- Dynamic modelling
- Design integration
- Economic assessment

Involved partners:

- Delft University of Technology
- MARIN
- Thyssen-Krupp Veerhaven
- viadonau

Prime effect: Reduction of NOx emissions

Ship type (CEMT VI): L 40m x B15m + 4 (or 6) EIIb barges

Key factors		
+	Applicable to existing engines	
-	Increased operational costs due to urea consumption	
-	No reduction of fuel consumption	

Effects
NOx emissions reduced
Meets future emissions requirements
Cost related to urea consumption

Suitable solution for any type of vessel

Investment	
Equipment	300,000 €
Conversion	80,000 €
Downtime	1 week

Economics	
Payback period	None
Nett present value (x1000)	n/a
Internal rate of return	n/a

4.3.1 Installation with SCR

Description of the retrofit option
A Selective Catalytic Reduction (SCR) installation is placed after the engines and the exhaust gases are mixed with urea and ammonia to reduce NOx emission.

Background of the MoVe IT business case
Veerhaven X sails on the Lower Rhine between Rotterdam and Duisburg: laden in upstream direction and empty downstream. All costs (capital, labour, fuel, interest as well as purchase, conversion, yard and docking costs) are based on West-European prize level.

Technical feasibility, technological maturity
This modernisation option is proven technology and available as a product of engine manufacturers. Several ships are equiped with SCR installations.

Bandwidth of the Gains/Investments and Effects
A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Enabling conditions and boundaries
This measure is generally suitable for existing engines to meet the future emission requirements. The installation requires space in the existing engine room or on deck.

Which actions to be undertaken :
The engine manufacturer or an engine service point is to be contacted to check the technical feasibility. A ship yard is to be consulted for an estimation of the conversion activities and resulting conversion costs.

Applicability to other ship types
This solution is suitable for existing diesel engines that are in proper technical condition.

More Information:
MoVe-It Deliverable 4.1 — 4.3 on Powering
MoVe-It Deliverable 7.1 — 7.3 on System Integration

Contact: M. Godjevac, TUDelft, +31 (0)15 27 82746

4.3.1

Waste heat recovery

Compagnie Fluviale Transport - CFT (F)) about

"Inflexible"

"Fuel efficiency could be a bit higher…"

Investigations:

- Full-scale measurements
- Propeller redesign
- CFD calculations
- Design integration
- Economic assessment

Involved partners:

- TU Delft
- MARIN
- Ecorys
- CFT
- University of Budapest

Prime effect: 1% - 1.5% reduction of fuel consumption

Canal Push Boat (CEMT IV-V): L 22.20m x B 9.45 + 2 EII barges

Key factors		
	+	Also in development for automotive industry
	-	Energy gain is small
	-	Considerable conversion effort

Effects
Reduced fuel consumption with 1.5%
1.5% less emissions (CO_2, NO_x, PM)

Suitable solution for -- vessels

Investment	
Equipment	28,000 €
Conversion	30,000 €
Downtime	3 weeks

Economics	
Payback period	> 25 years
Nett present value (x1000€)	< 0 €
Internal rate of return	< 0%

4.3.1

Waste heat recovery

Description of the retrofit option

The hot expanding exhaust gases are lead through a gasturbine, which on its own powers an electric generator. The gained electric power is fed into the board system.

Technical feasibility, technological maturity

This modernisation option is proven technology and available as a product of engine manufacturers. Several large sea-going container ships are equipped with waste heat recovery systems.

Enabling conditions and boundaries

This measure is generally not a suitable option for inland ships as the amount of waste energy in the exhaust gases is rather limited.

Applicability to other ship types

This solution is suitable for engines within the larger power ranges such as sea-going container ships, so not an option for an inland vessel.

Back ground of the MoVe IT business case

The Inflexible sails on the Seine between L'Havre and Paris. Purchase and fuel costs are based on West-European prize level; also for Labour and conversion costs, yard and docking costs.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 7.2

Which actions to be undertaken :

The engine manufacturer or an engine service point is to be contacted to check the technical feasibility. A ship yard is to be consulted for an estimating of the conversion activities and resulting conversion costs.

More Information:

MoVe-It Deliverable 7.1 — 7.3 on System Integration

Contact: Robert Hekkenberg, TUDelft, +31 (0)15 27 83117

Lessons Learned

Lesson 1: "The time horizon of investment is the determining factor"

Engine replacement comprises a large investment having a long payback period as a consequence. These kind of investments may be financially profitable only on the long term. So, the future perspectives are to be checked beforehand. Useful question then are: "How will my future revenue develop?" "What is the expected technical lifetime of my ship and the new engines?" For the rather shorter time horizons, an upgrade of the existing engines by application of exhaust gas after-treatment may be an option in order to improve the environmental performance of a vessel.

Lesson 2: "Diesel-direct propulsion still has a future perspective"

In general, diesel-direct configurations offer lowest energy consumption as no additional - energy consuming - power conversion takes place. However, application of Selective Catalytic Reduction and/or filters is needed to meet the future emission requirements. These measures generate additional costs without return on investment.

MoVe-It Deliverable 4.1 — 4.3 on Powering, Contact: M. Godjevac, TUDelft, +31 (0)15 27 82746

Lesson 3: "Gas engines are a good alternative for new ships to reduce NOx and CO_2

For future new builds, gas engines offer a large potential with respect to CO_2 and NOx emissions as well as economic performance. Implications on possible cargo space reduction are to be taken into account due to the lower density of liquefied gas and the required dedicated fuel tank system. For that reason this option is less suitable as a refit option for existing inland ships.

MoVe-It Deliverable 4.1 — 4.3 on Powering, Contact: M. Godjevac, TUDelft, +31 (0)15 27 82746

Colophon

For more information about Powering & Engines and/or System Integration

Please contact:

Delft University of Technology
Marine and Transport Technology
Ship Design, Production and Operations

Dr. Ir. Milinko Godjevac
Assistant Professor
Ship Powering
T: +31 (0)15 27 82746
E: M.Godjevac@tudelft.nl

Dr. Ir. Robert Hekkenberg
Assistant Professor
Ship Design
T: +31 (0)15 27 83117
E: R.G.Hekkenberg@tudelft.nl

For more information about the collaborative project or one of the work packages

Please contact:
Project Leader MoVe IT!

Mr. Meeuwis van Wirdum
MARIN – Team IWT
Project Coordinator

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 39 11
E: inlandship@marin.nl

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The guidelines are created by Erwin van Heumen, DST, on the basis of the work realised in the project.

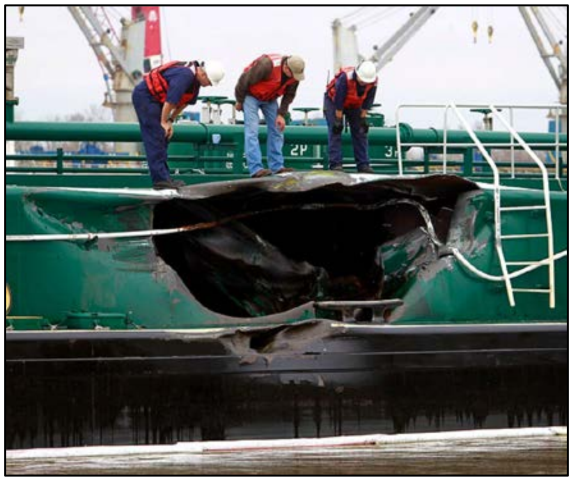
Please contact:

DST - Development Centre for Ship Technology and Transport Systems
Department Transport Systems
T: +49 (0)203 99 369 -51
E: scholten@dst-org.de
P.O. Box 10 13 49
47013 Duisburg
Germany

Stichting Projecten Binnenvaart (SPB) lead Move-It dissemination. For questions on dissemination you can contact SPB through the project coordinator or directly via: b.kelderman@binnenvaart.nl

Guidelines on Modernisation of Inland Ships

In order to improve inland waterway freight transport to the standards of tomorrow, inland shipping needs to MoVe IT!



Themes		Booklet
	General Guidelines	*1*
	Hydrodynamic Improvement	*2*
	Efficient ship operation	*3*
	Powering and Engines	*4*
	Ship Structures & Weight	*5*
	New Scales and Services	*6*

August 2014
MoVe-It Consortium
http://www.moveit-fp7.eu/

Preface

“In order to improve inland waterway transport to the standards of tomorrow, inland shipping needs to MoVe IT!”

- Meeuwis van Wirdum – Project leader -

Objective of this guidelines

MoVeIT! is a European research project, in which a set of options is developed for the modernisation of inland ships that meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

Hightech structures/Novel materials

*One of the main focal points of MoVe IT! is the application of **novel materials and designs** to the ship´s structure of single hull tankers in order to meet future safety regulations and operational requirements. Further, the cargo capacity of inland ships can be effectively increased by lengthening the ship hull with lightweight materials and designs. This leads to higher transport efficiency with a short return on investment.*

What’s MoVe-It?

Strengthening the future of existing IWT vessels by investigating retrofit options from both a technical and an economical perspective. MoVeIT! is a European research project. The project closely looks into vessels and their performance and develops a set of viable options for modernisation. These options will allow these vessels to meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

One of the main focal points of MoVe IT! is the modernisation of the ship´s main components in a way that is matched to the conditions it will face throughout its life. This will result in both significantly better performance compared to the ships old systems that are designed to fulfil a single design condition and the compliancy of new requirements and rules (ADN).

Table of Contents

MoVe IT! SEVENTH FRAMEWORK PROGRAMME

"Inland ships can be made safer and more effective by applying Novel Materials and Design to the ship structure!"

How to read this guidelines?

The following options in terms of material and design can be applied as retrofitting option as well as designs for new-buildings. The selected case studies will demonstrate the technical and economical feasibility and potential of the solutions. Detailed information however can be found in the Deliverables 5.1 — 5.4 on the MoVe IT! Website.

Introduction

Problem definition:

Due to upcoming new ADN regulations, a double hull structure will be mandatory after 2018 for all inland ships transporting dangerous goods. To allow further use, single hull tankers have to be retrofitted with a double hull or they will have to be used for other types of services.

Operators of inland ships have to deal with long periods of low water levels caused by long periods of dryness as well as with renewed rules and requirements for their vessels.

What are new materials and designs:

New materials and designs are defined in this manner as those not typically used in the inland navigation. This includes for instance composites and sandwich designs: Composites made of fibre reinforced plastics are commonly used in other industries and offer great potentials in terms of strength and weight; Sandwich designs offer a high stiffness to weight and height ratio.

What did MoVe IT! do?

• • •

The general target of the work is to examine and understand the main critical parameters regarding the structures of the cargo ships and apply smart material and design solutions.

Two reference ships were selected, one for each of the two structural modifications, i.e., ship lengthening and retrofitting of a double hull. The structural modifications and options are suitable for retrofitting as well as for the application in new-building designs.

5.2.1

ADN double steel hull

MoVe IT! Consortium about:

Internautic-1

"Exit by 2018 due to single hull"

Investigations:

- FE calculations
- Crash simulations
- Strength analysis
- Risk assessment
- Economic assessment

Involved partners:

- CMT
- TNO
- SMILE FEM
- SICOMP
- SDG & University of Galati

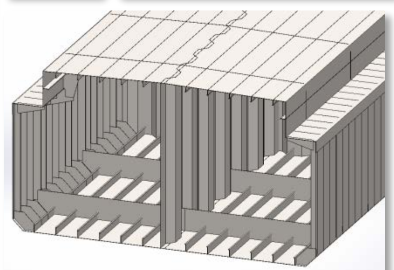
Prime effect: Tanker meets ADN-requirements

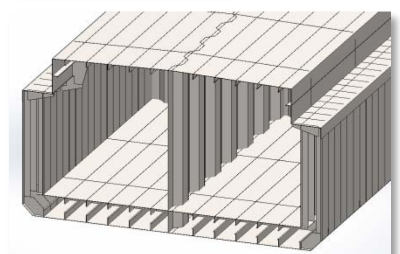
Motor Tank Vessel (CEMT IV): L85m x B9.5m – 1685 ton

Key factors			Effects	
	+	*Proven technology*		*ADN-requirements fulfilled*
	+	*Low investment*		*All steel - known technology*
	0	*Reduced cargo capacity*		*Basic crashworthiness according to ADN*

Applicability to other ship types : Suitable solution for any tanker or tank barge

Investment			Economics		
	Equipment	*25,000 €*		*Payback period*	*7 years*
	Conversion	*250,000 €*		*Nett present value (x1000€)*	*n/a*
	Downtime	*8 weeks*		*Internal rate of return*	*5 %*





5.2.1

ADN double steel hull

Description of the retrofit option

The standard double hull consists of plates which are stiffened by frames. The hull is constructed from mild steel without any unusual structural solutions. Hence, the structures are designed according ADN.

Back ground of the MoVe IT business case

The economic calculation is based on a freight rate of 0.04 € per ton and km. The added service time is 15 years; Route length: 225 km (Rotterdam-Duisburg) with one full, one empty leg.

Technical feasibility, technological maturity

The proposed modernisation option is proven technology and used for retrofitting or new-building. However, this standard is not optimised towards strength, crashworthiness or space.

Bandwidth of the Gains/Investments and Effects

The bandwidth is minimal due to standard material, design and production. By applying to the rules, the economic and ecologic effect is negative due to a smaller cargo-space and more lightweight

Enabling conditions and boundaries of this option/technology

Applying a steel double hull according to ADN and class rules is not limited to certain boundaries.

Which actions to be undertaken :

There are no special actions for an ADN double hull in steel. However, due to the age of the ships to be retrofitted, the level of corrosion should be determined and evaluated.

Applicability to other ship types

Barges and self- propulsioned ships can be retrofitting by this kind of double hull

More Information:

- Please read MoVe-It Deliverable 5.2 and 5.4.
- Contact: Dr. Lars Molter , CMT,

  +49 (40) 69 20 876-0

λ-shape steel double hull

MoVe IT! Consortium about:

Internautic-1

“Exit by 2018 due to single hull”

Investigations:

- FE calculations
- Crash simulations
- Strength analysis
- Risk assessment
- Economic assessment

Involved partners:

- CMT
- TNO
- SMILE FEM
- SICOMP
- SDG & University of Galati

Prime effect: Tanker meets ADN-requirements

Motor Tank Vessel (CEMT IV): L85m x B9.5m – 1685 ton

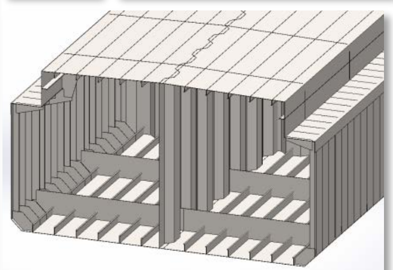
Key factors		
+	Applied technology	
+	Optimised cargo space	
-	Complex structure	

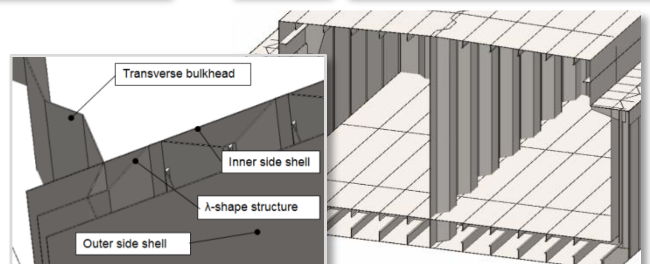
Effects
ADN-crash-requirements fulfilled
High crashworthiness
Full steel solution

Applicability to other ship types : Suitable solution for any tanker or tank barge

Investment	
Equipment	25,000 €
Conversion	290,000 €
Downtime	7 weeks

Economics	
Payback period	8 years
Nett present value (x1000€)	n/a
Internal rate of return	5 %





λ-shape steel double hull

Description of the retrofit option

The λ-shape structures is a currugated plate welded to the stiffened structure. For retrofitting, it is much easier to integrate into an existing single hull with stiffeners compared to other steel sandwich solutions.

Back ground of the MoVe IT business case

The economic calculation is based on a freight rate of 0.04 € per ton and km. The added service time is 15 years; Route length: 225 km (Rotterdam-Duisburg) with one full, one empty leg.

Technical feasibility, technological maturity

This option is already used in another design for chemical tankers. These structures were test wise installed under the supervision of GL class.

Bandwidth of the Gains/Investments and Effects

The economic effect due to the larger cargo space is noticeable. By optimising the design, the economic impact could be increased. Using this design in new-building would be the best variant.

Enabling conditions and boundaries of this option/technology

There are no known boundaries for using this option. However, there are special conditions in terms of repair and maintenance.

Which actions to be undertaken :

An engineering bureau should to be contracted to optimise the structure and get approval by classification society.

Applicability to other ship types

Barges and self- propulsioned ships can be retrofitting by this kind of double hull.

More Information:

- Please read MoVe-It Deliverable 5.2 and 5.4.
- Contact: Dr. Lars Molter , CMT,

  +49 (40) 69 20 876-0

5.2.3

Steel-Foam-Steel double hull

MoVe IT! Consortium about:

Internautic-1

"Exit by 2018 due to single hull"

Investigations:

- FE calculations
- Crash simulations
- Strength analysis
- Risk assessment
- Economic assessment

Involved partners:

- CMT
- TNO
- SMILE FEM
- SICOMP
- SDG & University of Galati

Prime effect: Tanker meets ADN-requirements

Motor Tank Vessel (CEMT IV): L85m x B9.5m – 1685 ton

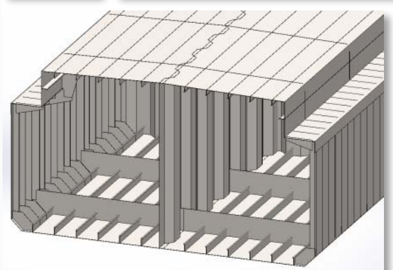
Key factors		
+	Used technology in other industries	
+	Optimised cargo capacity possible	
-	No class approval yet	

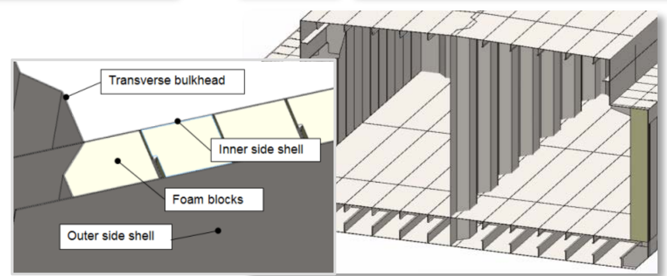
Effects
ADN-crash-requirements fulfilled
Improved crashworthiness
Higher economic potential compared to standard ADN steel double hull

Applicability to other ship types : Suitable solution for any coupled convoy

Investment	
Equipment	25,000 €
Conversion	375,000 €
Downtime	7 weeks

Economics	
Payback period	10 years
Nett present value (x1000€)	n/a
Internal rate of return	5 %





5.2.3

Steel-Foam-Steel double hull

Description of the retrofit option

The double hull consists of polymer-foam (XPS) integrated in the sides of the hull between the existing steel frames and stiffeners and covered by an inner side plate in steel.

Back ground of the MoVe IT business case

The economic calculation is based on a freight rate of 0.04 € per ton and km. The added service time is 15 years; Route length: 225 km (Rotterdam-Duisburg) with one full, one empty leg.

Technical feasibility, technological maturity

The proposed modernisation option is a available product and used in several non-maritime applications. Bonding is feasible and a known joining technique.

Bandwidth of the Gains/Investments and Effects

The bandwidth is minimal due to the scantlings according to ADN. The structure can be optimised acc. to max. crashworthiness or space. This will effect in a high safety level or higher economic impact.

Enabling conditions and boundaries of this option/technology

There are no known boundaries for using this option. However, there are special conditions in terms of repair and maintenance.

Which actions to be undertaken :

An engineering bureau should to be contracted to optimise the structure and get approval by classification society.

Applicability to other ship types

Barges and self-propulsioned ships can be retrofitting by this kind of double hull.

More Information:

- *Please read MoVe-It Deliverable 5.2 and 5.4.*
- *Contact: Dr. Lars Molter , CMT,*

  +49 (40) 69 20 876-0

Lengthening with composite materials

Ship-owner Plimsoll Ltd. (H) about

Herso-1

"Limited cargo capacity"

Investigations:

- FE calculations
- Crash simulations
- Strength analysis
- Risk assessment
- Economic assessment

Involved partners:

- CMT
- TNO
- SMILE FEM
- SICOMP
- SDG & University of Galati

Prime effect: increased payload with 340 ton

Motor cargo vessel (CEMT IV): L85m x B9.5m – 1380 ton

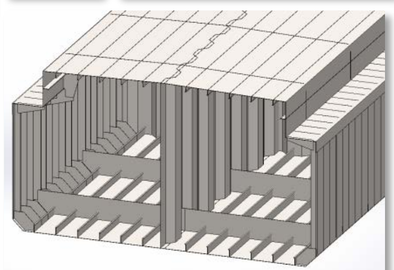
Key factors	
+	*Relatively low investment*
+	
-	

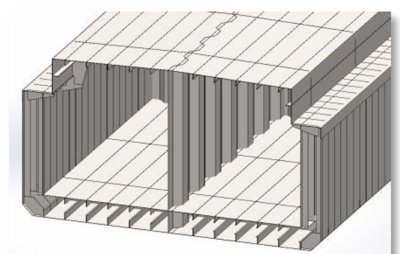
Effects
Increased payload and cargo space
Increased transport performance
Reduced transport costs

Applicability to other ship types : ***Suitable solution for any motor cargo vessel***

Investment	
Equipment	*100,000 €*
Conversion	*120,000 €*
Downtime	*4 weeks*

Economics	
Payback period	*4 – 6 years*
Nett present value (x1000€)	*730*
Internal rate of return	*44%*





5.3.1

Lengthening with composite materials

Description of the retrofit option

The cargo hold of the motor cargo vessel is extended with about 15 m. The ship is equiped with a powerful engine that even enables pushing a barge, the increased power demand can be brought up. The larger cargo capacity leads to lower transport costs.

Back ground of the MoVe IT business case

Herso-1 sails on the Upper and Middle Danube between Regensburg and Budapest. Purchase and fuel costs are based on West-European prize level; Labour and conversion costs, yard and docking costs on Eastern-European level.

Technical feasibility, technological maturity

The proposed modernisation option is proven technology.

Bandwidth of the Gains/Investments and Effects

Effects on e.g. fuel consumption, emissions of 15% (+/- 5%)... Investments 100% (+/- 10%) as in the economic feasibility study D7.2

Enabling conditions and boundaries

Exceeding a ship length of 70m or 86m leads to increased labour costs due to larger required crew. Propeller properties have to be checked as a more thrust is to be delivered at a lower ship speed.

Which actions to be undertaken :

An experienced shipyard is to be contacted to design, construct and build the midship structure. Further it is advisory to contact a classification society about ship strength and required scantlings.

Applicability to other ship types

This measure is generally applicable to motor cargo vessels of which the ship structure is in good condition and enough propulsive power is available.

More Information:

- Please read MoVe-It Deliverable 5.2 and 5.4.
- Contact: Dr. Lars Molter , CMT,

  +49 (40) 69 20 876-0

Lessons Learned

Lesson 1: "Novel materials and alternative structural design can make inland ships safer and more effective!"

The structural modifications and options are suitable for retrofitting as well as for the application in new-building designs. From a technical point of view all suggested solutions are feasible considering global and local strength of the hull with some minor issues which can be solved.

Lesson 2: "Conventional steel structures are most suitable for retrofit purposes"

In spite of the better economical performance against steel structures, the implementation of novel materials to existing ships may be difficult as time-consuming effort has to be made to convince the classification societies and authorities.

Lesson 3: "Novel materials have large potential for new-building projects"

The introduction of novel materials to inland ships may be easier in case of new-building projects as the design can be optimised to it. Another advantage is that the costs due for research & development and type/product approval may be spread over multiple ship orders.

Colophon

For more information about Structures & Weight

Please contact:

Dr. Lars Molter
Naval Architect, M.Eng.

CENTER OF MARITIME TECHNOLOGIES e.V.
Bramfelder Str. 164
D-22305 Hamburg
Germany

T: +49 (0)40 69 20 876 0
F: +49 (0)40 69 20 876 66
E: info@cmt-net.org

For more information about the collaborative project or one of the work packages

Please contact:
Project Leader MoVe IT!

Mr. Meeuwis van Wirdum
MARIN – Team IWT
Project Coordinator

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 39 11
E: inlandship@marin.nl

www.moveit-fp7.eu

These guidelines are part of Move IT! dissemination

The guidelines are created by Erwin van Heumen, DST, on the basis of the work realised in the project.

Please contact:

DST - Development Centre for Ship Technology and Transport Systems
Department Transport Systems
T: +49 (0)203 99 369 -51
E: scholten@dst-org.de
P.O. Box 10 13 49
47013 Duisburg
Germany

Stichting Projecten Binnenvaart (SPB) lead Move-It dissemination. For questions on dissemination you can contact SPB through the project coordinator or directly via: b.kelderman@binnenvaart.nl

Colofon

For more information about Structure & Weight …

Please contact:

Dr. Lars Molter
Naval Architect, M.Eng.

CENTER OF MARITIME TECHNOLOGIES e.V.
Bramfelder Str. 164
D-22305 Hamburg
Germany

T: +49 (0)40 69 20 876 0
F: +49 (0)40 69 20 876 66
E: info@cmt-net.org

For more information about the collaborative project or one of the work packages …

Please contact:

MoVeIT! Dissemination Team

C/a EICB
PO Box 23133
3001 KC ROTTERDAM

T: +31 (0)10 798 98 30
F: +31 (0)10 412 90 91
E: office@eicb.nl

www.moveit-fp7.eu

Project Leader MoVe IT! …

Please contact:

Meeuwis van Wirdum
Project Manager
Inland Waterway Transport

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 34 72
F: +31 (0)317 12 12 34
E: M.v.Wirdum@marin.nl.

Guidelines on Modernisation of Inland Ships

In order to improve inland waterway freight transport to the standards of tomorrow, inland shipping needs to MoVe IT!

Themes		Booklet
	General Guidelines	*1*
Themes	*Hydrodynamic Improvement*	*2*
	Efficient ship operation	*3*
	Powering and Engines	*4*
	Ship Structures & Weight	*5*
	New Scales and Services	*6*

August 2014
MoVe-It Consortium
http://www.moveit-fp7.eu/

Preface

"In order to improve inland waterway transport to the standards of tomorrow, inland shipping needs to MoVe IT!"

- Meeuwis van Wirdum – Project leader -

What's MoVe-It?

•••

Strengthening the future of existing IWT vessels by investigating retrofit options from both a technical and an economical perspective. MoVeIT! is a European research project. The project closely looks into vessels and their performance and develops a set of viable options for modernisation. These options will allow these vessels to meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

One of the main focal points of MoVe IT! is the modernisation of the ship´s main components in a way that is matched to the conditions it will face throughout its life. This will result in both significantly better performance compared to the ships old systems that are designed to fulfil a single design condition and the compliancy of new requirements and rules (ADN).

Objective of this guidelines

•••

MoVeIT! is a European research project, in which a set of options is developed for the modernisation of inland ships that meet the challenges of the over-aging of the fleet, climate change and greater environmental objectives. One of the final results is a decision support regarding the application of these options.

New Scales & Services

•••

One of the main focal points of MoVe IT! Is the upgrade of smaller ship types. The cargo capacity can be effectively increased by lengthening the ship hull with conventional methods This leads to higher transport efficiency with a short return on investment. Further, cost effective adaptation measures are found to cope with negative effects of climate change. Adaptation of inland ships to transport CO2 gas, however, shows not to be an economically feasible retrofit option.

Contents

"New scales and/or services can increase the transport performance of rather smaller ship types"

How to read this guidelines? ...

The following options in terms of scale enlargement or adaptation to changing circumstances can be applied as retrofitting option. The selected case studies demonstrate the technical and economical feasibility of the solutions as decision aid. Detailed information however can be found in the Deliverables 6.1 — 6.6 on the MoVe IT! Website.

Lengthening

Problem definition:

Smaller ships have to bare a lack of scale economy. Due to their smaller cargo capacity, the transport costs per unit cargo are rather high. As a consequence, the number of these smaller units is decreasing over the last decade.

Investigated solutions:

Two small inland ships were investigated and upgraded by means of stepwise lengthening with conventional steel mid-ship sections. Further, the influence of an improved propulsion was assessed by applying a nozzle to the propeller.

It was shown that the performance of the ships increases with increasing length of the cargo hold. However, large differences in economic feasibility could be examined.

What did MoVe IT! do?

The objective of MoVe IT! (Modernisation of vessels for inland waterway freight transport) project is to investigate cost-effective options for modernisation of the European inland fleet. One of the project tasks was to examine the feasibility of lengthening of existing small vessels (LOA < 86m) from both the technical and the economic point of view. With respect to that, the gradual lengthening (in several predefined steps) of two typical inland vessels of CEMT class II and III was examined. For each step, the ship structure scantlings were verified against the rules of classification societies, the manoeuvring features were simulated and the power necessary for attaining certain speed was calculated. Finally, the economic and environmental impacts of lengthening were assessed.

6.2.1 Lengthening (70 m to 88 m) + nozzle

Technical feasibility and cost-effectiveness of lengthening of CEMT III/IV class vessel operating on the Rhine.

Investigations:

- Strength of vessel structure
- Manoeuvrability
- Powering
- Economic assessment
- Environmental impact

Involved partners:

- University of Belgrade
- CMT
- MARIN
- TU Delft
- Ecorys
- Ship Design Group
- University of Galati

Prime effect: additional mass of cargo up to 21.5 t/m

Key factors

- Present in shipbuilding practice
- Economy of scale benefits
- Improved efficiency in shallow water

Effects

- Up to 35% more cargo
- Speed loss 1- 2 km/h
- Less emissions per tkm

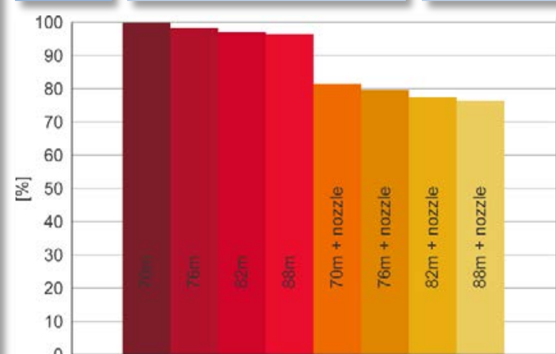
Applicability to other ship types : Suitable for dry cargo self-propelled vessels

Investment

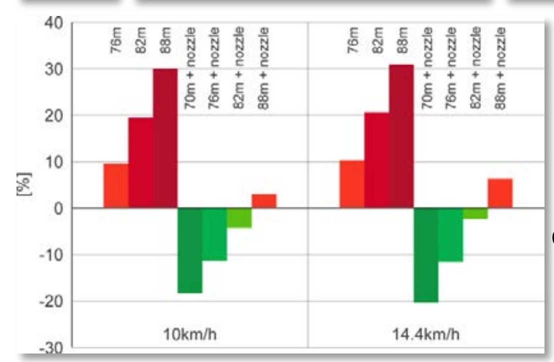
Structure	180,000 €
New engine, new rudder and nozzle	390,000 €
Downtime	4 weeks

Economics

Payback period	2 years
Nett present value (x1000€)	3,300
Internal rate of return	82% – 90%



Decrease of emissions per tkm



Change in emissions relative to original

6.2.1

Lengthening (70 m to 88 m) + nozzle

MoVe IT! SEVENTH FRAMEWORK PROGRAMME

Description of the retrofit option

The cargo hold of the motor cargo vessel is extended with about 18 m. The larger cargo capacity leads to lower transport costs, due to economy of scale. Further the propulsion efficiency was increased by application of a nozzle propeller.

Back ground of the MoVe IT business case

The Hendrik is assumed to operate 48 weeks a year, completing one round trip on weekly basis on a 100km stretch of the Rhine. All costs are on Western-European level.

Technical feasibility, technological maturity

The proposed modernisation option is not a novelty. As lengthening is common practice, it can be considered as proven technology.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied -/+ 20% and fuel costs -/+ 10% and variation of freight rates in -/+ 25% range. The results can be found in the economic feasibility study of Deliverable 6.4.

Enabling conditions and boundaries

Exceeding a ship length of certain threshold length may lead to increased labour costs due to larger required crew. Propeller properties have to be checked as a more thrust is to be delivered at a lower ship speed. Further conditions in Deliverable 6.1 – 6.4.

Which actions to be undertaken:

An experienced shipyard is to be contacted for design and engineering. t is recommended to contact a hydrodynamics institute for a proper power prediction and a classification society about ship strength and required scantlings.

Applicability to other ship types

This measure is generally applicable to motor cargo vessels of which the ship structure is in good condition and enough propulsive power is available. Tankers should be ruled out due to new double hull requirements.

More Information:

- Please read MoVe-It Deliverables 6.1 – 6.4.
- Contact: Igor Bačkalov, University of Belgrade, +381 11 3229 281 ibackalov@mas.bg.ac.rs

6.2.2

Lengthening (70 m to 76 m) + no nozzle

Technical feasibility and cost-effectiveness of lengthening of CEMT III/IV class vessel operating on the Rhine.

Investigations:

- Strength of vessel structure
- Manoeuvrability
- Powering
- Economic assessment
- Environmental impact

Involved partners:

- University of Belgrade
- CMT
- MARIN
- TU Delft
- Ecorys
- Ship Design Group
- University of Galati

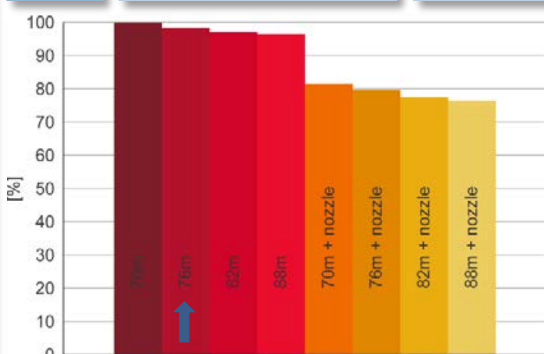
Prime effect: additional mass of cargo up to 21.5 t/m

Key factors	Effects
Present in shipbuilding practice	Up to 35% more cargo
Economy of scale benefits	Speed loss 1- 2 km/h
Improved efficiency in shallow water	Less emissions per tkm

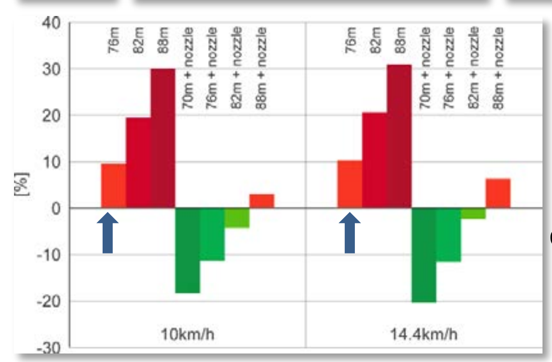
Applicability to other ship types : Suitable for dry cargo self-propelled vessels

Investment	
Structure	180,000 €
New engine, new rudder and nozzle	390,000 €
Downtime	4 weeks

Economics	
Payback period	6 years
Nett present value (x1000€)	760 - 830
Internal rate of return	20%



Decrease of emissions per tkm



Change in emissions relative to original

6.2.2 Lengthening (70 m to 76 m) + no nozzle

Description of the retrofit option

The cargo hold of the motor cargo vessel is only extended with about 7 m. The larger cargo capacity leads to lower transport costs, due to economy of scale. However, the measure is less effective as case 6.2.1.

Back ground of the MoVe IT business case

The Hendrik is assumed to operate 48 weeks a year, completing one round trip on weekly basis on a 100km stretch of the Rhine. All costs are on Western-European level.

Technical feasibility, technological maturity

The proposed modernisation option is not a novelty. As lengthening is common practice, it can be considered as proven technology.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied -/+ 20% and fuel costs -/+ 10% and variation of freight rates in -/+ 25% range. The results can be found in the economic feasibility study of Deliverable 6.4.

Enabling conditions and boundaries

Exceeding a ship length of certain threshold length may lead to increased labour costs due to larger required crew. Propeller properties have to be checked as a more thrust is to be delivered at a lower ship speed. Further conditions in Deliverable 6.1 – 6.4.

Which actions to be undertaken:

An experienced shipyard is to be contacted for design and engineering. t is recommended to contact a hydrodynamics institute for a proper power prediction and a classification society about ship strength and required scantlings.

Applicability to other ship types

This measure is generally applicable to motor cargo vessels of which the ship structure is in good condition and enough propulsive power is available. Tankers should be ruled out due to new double hull requirements.

More Information:

- Please read MoVe-It Deliverables 6.1 – 6.4.
- Contact: Igor Bačkalov, University of Belgrade, +381 11 3229 281 ibackalov@mas.bg.ac.rs

6.2.3

Lengthening (57.5 m to 69.5 m)

Technical feasibility and cost-effectiveness of lengthening of CEMT II class vessel operating on the Danube.

Investigations:

- Strength of vessel structure
- Manoeuvrability
- Powering
- Economic assessment
- Environmental impact

Involved partners:

- University of Belgrade
- CMT
- MARIN
- TU Delft
- Ecorys
- Ship Design Group
- University of Galati

Prime effect: additional mass of cargo up to 13 t/m

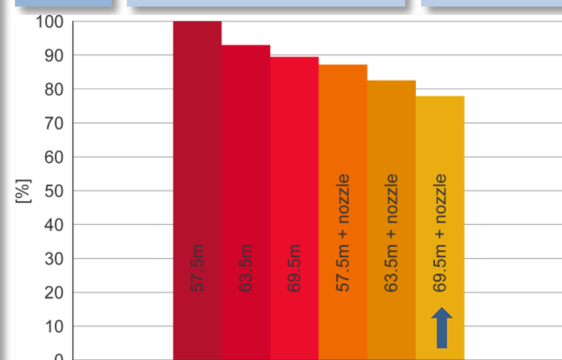
Key factors	
	Present in shipbuilding practice
	Economy of scale benefits
	Improved efficiency in low water

Effects	
	Increased cargo capacity of 29%
	Reduced emmisions per tkm with 22%
	Speed loss 1- 2 km/h

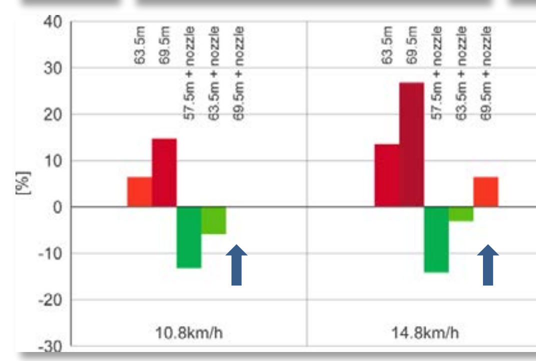
Applicability to other ship types : Suitable for dry cargo self-propelled vessels

Investment		
	Structure	80,000 €
	New engine and nozzle	290,000 €
	Downtime	4 weeks

Economics		
	Payback period	6 – 7 years
	Nett present value (x1000€)	300 – 380
	Internal rate of return	20%



Decrease of emissions per tkm



Change in emissions relative to original

6.2.3

Lengthening (57.5 m to 69.5 m)

MoVe IT! SEVENTH FRAMEWORK PROGRAMME

Description of the retrofit option

The cargo hold of the motor cargo vessel is only extended with about 12 m. The larger cargo capacity leads to lower transport costs, due to economy of scale.

Back ground of the MoVe IT business case

The Rheinland is assumed to complete 15 round trips per year on a 1000 km stretch of the Danube. All costs are on an Eastern-European level.

Technical feasibility, technological maturity

The proposed modernisation option is not a novelty. As lengthening is common practice, it can be considered as proven technology.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied -/+ 20% and fuel costs -/+ 10% and variation of freight rates in -/+ 25% range. The results can be found in the economic feasibility study of Deliverable 6.4.

Enabling conditions and boundaries

Exceeding a ship length of certain threshold length may lead to increased labour costs due to larger required crew. Propeller properties have to be checked as a more thrust is to be delivered at a lower ship speed. Further conditions in Deliverable 6.1 – 6.4.

Which actions to be undertaken:

An experienced shipyard is to be contacted for design and engineering. t is recommended to contact a hydrodynamics institute for a proper power prediction and a classification society about ship strength and required scantlings.

Applicability to other ship types

This measure is generally applicable to motor cargo vessels of which the ship structure is in good condition and enough propulsive power is available. Tankers should be ruled out due to new double hull requirements.

More Information:

- *Please read MoVe-It Deliverables 6.1 – 6.4.*
- *Contact: Igor Bačkalov, University of Belgrade, +381 11 3229 281 ibackalov@mas.bg.ac.rs*

6.2.4 Hull lengthening, from 57.5m to 63.5m

Technical feasibility and cost-effectiveness of lengthening of CEMT II class vessel operating on the Danube.

Investigations:

- Strength of vessel structure
- Manoeuvrability
- Powering
- Economic assessment
- Environmental impact

Involved partners:

- University of Belgrade
- CMT
- MARIN
- TU Delft
- Ecorys
- Ship Design Group
- University of Galati

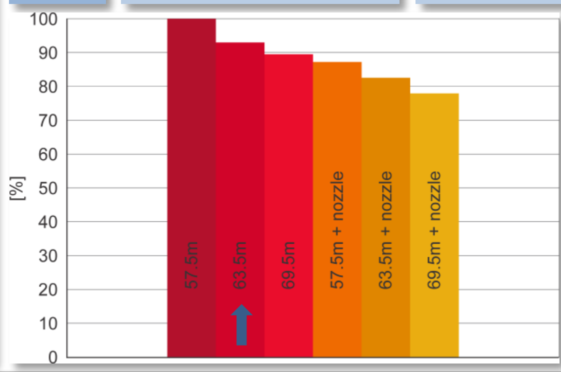
Prime effect: additional mass of cargo up to 13 t/m

Key factors	Effects
Present in shipbuilding practice	Increased cargo capacity
Economy of scale benefits	Reduced emmisions per tkm with 9%
Improved efficiency in low water	Speed loss 1- 2 km/h

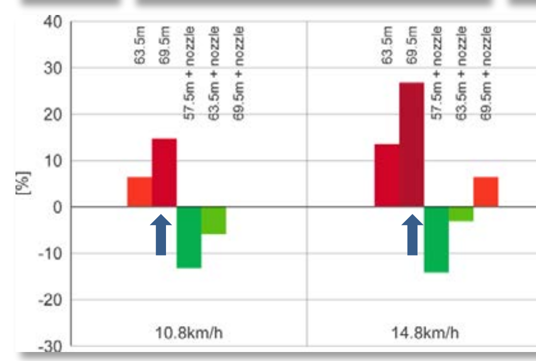
Applicability to other ship types : Suitable for dry cargo self-propelled vessels

Investment	
Structure	80,000 €
New engine and nozzle	290,000 €
Downtime	4 weeks

Economics	
Payback period	> 26 years
Nett present value (x1000€)	-27
Internal rate of return	4%



Decrease of emissions per tkm



Change in emissions relative to original

6.2.4

Lengthening (57.5 m to 63.5 m)

Description of the retrofit option

The cargo hold of the motor cargo vessel is only extended with about 6 m. The larger cargo capacity leads to lower transport costs, due to economy of scale. However, the benefit does not weigh the costs.

Technical feasibility, technological maturity

The proposed modernisation option is not a novelty. As lengthening is common practice, it can be considered as proven technology.

Enabling conditions and boundaries

Exceeding a ship length of certain threshold length may lead to increased labour costs due to larger required crew. Propeller properties have to be checked as a more thrust is to be delivered at a lower ship speed. Further conditions in Deliverable 6.1 – 6.4.

Applicability to other ship types

This measure is generally applicable to motor cargo vessels of which the ship structure is in good condition and enough propulsive power is available. Tankers should be ruled out due to new double hull requirements.

Back ground of the MoVe IT business case

The Rheinland is assumed to complete 15 round trips per year on a 1000 km stretch of the Danube. All costs are on an Eastern-European level.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied -/+ 20% and fuel costs -/+ 10% and variation of freight rates in -/+ 25% range. The results can be found in the economic feasibility study of Deliverable 6.4.

Which actions to be undertaken:

An experienced shipyard is to be contacted for design and engineering. t is recommended to contact a hydrodynamics institute for a proper power prediction and a classification society about ship strength and required scantlings.

More Information:

- Please read MoVe-It Deliverables 6.1 – 6.4.
- Contact: Igor Bačkalov, University of Belgrade, +381 11 3229 281 ibackalov@mas.bg.ac.rs

Adaptation to Climate Change

Problem definition:
Recent studies indicate that major worsening due to low water period as negative effect of climate change is mainly to be expected in the second half of this century, which is beyond the time horizon of retrofit solutions investigated within Move-IT. Still, also in the current situation, improvements to ships that reduce their sensitivity to low water levels may contribute to improved performance in low water operating conditions. Especially larger sized ships (larger draught) are susceptible to low water periods, and their operating costs will increase extensively. Smaller sized ships on the contrary, having a much lower draught are much less vulnerable to water fluctuations, but do face a scale disadvantage against larger sized ships.

Investigated solutions:
Two promising measures are investigated: the adjustable propeller tunnel for larger and therefore rather low-water sensitive ships and upgrade to coupled convoys for smaller, less low-water sensitive vessels to improve the transport performance.

What did MoVe IT! do?

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One of the aim of MoVe IT! was to investigate how existing vessels can better cope with the low water levels in the rivers due to the changing climate. For the adaptation of ships to lower water levels, different technical approaches are possible. They are were analysed and assessed with regards to their feasibility and practicability, using a business case approach describing the technical and economic feasibility of adjusting the ships.

Application of Adjustable Tunnels

Technical feasibility and cost-effectiveness of Adjustment to Negative Effects of Climate Change.

Investigations:

- Technical feasibility study
- Simulation of navigation conditions based on future climate scenarios
- Economic assessment

Involved partners:

- DST
- ECORYS
- University of Belgrade

Prime effect: reduction of waterlevel related non-operational days

Large Rhine Vessel - CEMT Va - L 110m x B 11.45 – 3000 ton

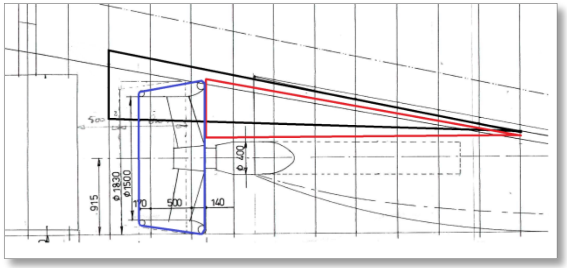
Key factors		
+	Promising technology	
+	Available product	
-	Not applied to ships yet	

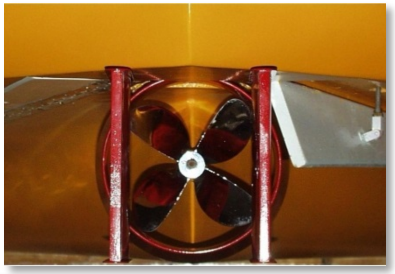
Effects
Large reduction non-operational days even in pessimistic climate scenario
7-10% Higher fuel efficiency
7% Reduction in transport costs

Suitable solution for inland vessels with appropriate aft ship geometry

Investment	
Equipment	250,000 €
Conversion	100,000 €
Downtime	6 weeks

Economics	
Payback period	3 – 4 years
Nett present value (x1000€)	875 – 1135
Internal rate of return	35 –48 %





6.3.1

Application of Adjustable Tunnels

Description of the retrofit option

Existing fixed tunnel skirts are removed and replaced by adjustable ones. At favourable water depths the tunnel skirts retracted, which provides excellent propeller inflow; at low water depths they are hinged down leading to an even more-pronounced tunnel geometry.

Back ground of the MoVe IT business case

A 110m large Rhine ship type is assumed to sail on the Rhine between Rotterdam and Karlsruhe. Water levels based on pessimistic climate scenario. All costs on Western-European level.

Technical feasibility, technological maturity

This promising modernisation option is extensively tested on model scale. On the market as available product FlexTunnel, but not applied to ships yet. So-called: "development state".

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 6.5.

Enabling conditions and boundaries of this option/technology

The aft form of the ship should provide more beneficial inflow of the propeller if the tunnel skirts are removed.

Which actions to be undertaken :

Hydrodynamic investigation of the propeller inflow are advisory e.g by model testing or CFD calculations. Shipyard is to be contacted regarding ship structure and engine room arrangement.

Applicability to other ship types

The Adjustable Tunnel is generaly applicable to motor cargo vessels that can provide an open and smooth aft ship form leading to beneficial propeller inflow. Best suitable for newbuildings as hull shape can be optimised with limited effort.

More Information:

- Please read MoVe-It Deliverables 6.5.
- Contact: Erwin van Heumen, DST, +49 203 99 369 51 heumen@dst-org.de

Operation as coupled convoy

Technical feasibility and cost-effectiveness of Adaptation to Negative Effects of Climate Change.

Investigations:

- Technical feasibility study
- Simulation of navigation conditions based on future climate scenarios
- Economic assessment

Involved partners:

- DST
- ECORYS
- University of Belgrade

Prime effect: cost reduction of 40%

Motor cargo vessel - CEMT IV - L85m x B9.5m - 1350 ton

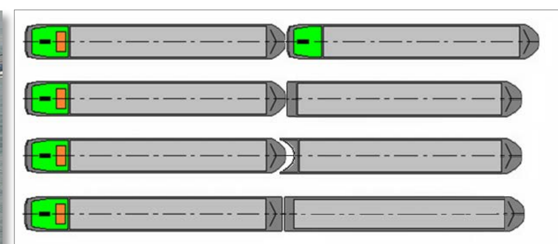
Key factors		
+	Proven technology
+	Economy of scale benefits
-	Larger crew

Effects
Cost reduction per ton of 40%
Remaining cargo capacity even at extreme low water levels

Suitable solution for various motor cargo vessels

Investment	
Equipment	250,000 €
Conversion	250,000 €
Downtime	2 weeks

Economics	
Payback period	4 – 9 years
Nett present value (x1000€)	255 – 475
Internal rate of return	12 –27 %



6.3.2

Operation as coupled convoy

Description of the retrofit option
An low-cost, improvised coupled convoy is achieved with a motor cargo vessel that pushes another obsolete vessel from the same type or barge. Pushing shoulder and coupling winches are to be applied.

Technical feasibility, technological maturity
The proposed modernisation option is not a novelty. Conversion to coupled convoys is common practice, it can be considered as proven technology.

Enabling conditions and boundaries of this option/technology
Sufficient engine power should be installed in the pushing motor cargo vessel to achieve required speed and stopping-ability.

Applicability to other ship types
This solutions is generally applicable to motor cargo vessels of various types.

Back ground of the MoVe IT business case
Johann Welker ship type, sailing on Rhine river between Rotterdam and Karlsruhe. Water levels based on pessimistic climate scenario. All costs on Western-European level.

Bandwidth of the Gains/Investments and Effects
A sensitivity analysis has been performed, in which investment are varied (+20%, -20%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 6.5.

Which actions to be undertaken:
An experienced shipyard is to be contacted for design and engineering. It is recommended to contact a hydrodynamics institute for advise with respect to the propeller characteristics and a power prediction.

More Information:
- Please read MoVe-It Deliverables 6.5.
- Contact: Erwin van Heumen, DST, +49 203 99 369 51 heumen@dst-org.de

6.4

Adaption to CO_2 transport

Problem definition:

The transportation of CO2 is often considered as a potential market for inland shipping, for which so far no suitable capacity exists, nor specific rules are in place. For the amounts of CO2 that would result if Carbon Capture and Storage (CCS) are applied to large power plants, ships and transport systems would be needed to be developed.

Investigated solution:

Adaptation of existing inland vessels to CO2 transport was addressed as a candidate solution and as possible retrofit solution. Transport of liquefied CO2 in independent pressure tanks has been analysed and considered as technically feasible in general sense. However the solution was found to be economically not feasible as the transport costs for IWT already exceed the current (Apr. 2013) price of CO2 certificates.

What did MoVe IT! do?

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The aim of task 6.6 is to investigate if existing vessels can be modified into CO2-tankers. Following investigations were carried out:

1. Market analysis to identify the potential markets for CO2 transport, relevant transport relations and its place in a multi-modal transport chain; 2. Investigation of technical and logistical requirements regarding CO2 storage and transport on board inland ships; 3. Economic feasibility study comprising a cost break-down for CCS, cost estimation for CO2 transport with adapted inland ships and a comparison with the price development of Certified Emission Reduction units (CERs)

An approach, comprising transport of liquefied CO2 in independent pressure tanks, was analysed and assessed with regards to its technical and economic feasibility. This is worked out in a business case for a 110m Large Rhine Vessel sailing on a 1200 km roundtrip between a power plant and a sea port

6.4.1

Adaption to CO_2 transport

Technical feasibility and cost-effectiveness of Adaptation to CO2 transport.

Investigations:

- Technical feasibility study
- Economic assessment

Involved partners:

- DST
- ECORYS
- University of Belgrade

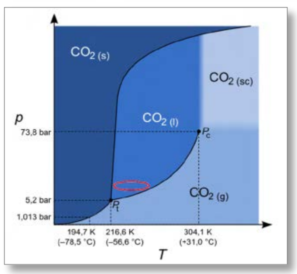
Prime effect: New service by conversion to CO_2 tanker

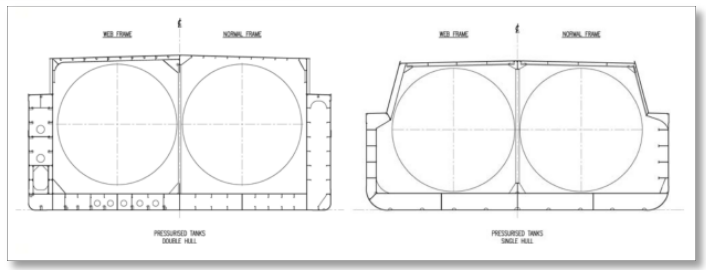
Large Rhine Vessel - CEMT Va - L 110m x B 11.45 – 3000 ton

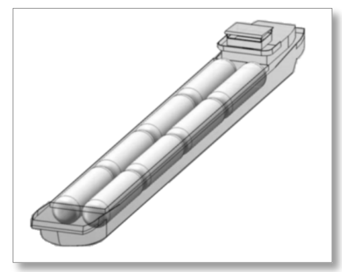
Key factors			Effects
+	Technically feasible		Liquefied CO2 transport possible with independent tanks (type C)
-	Economically NOTfeasible		
-	Transport costs too high		

Option economically not feasible at for inland ships

Investment			Economics	
Equipment	3,000,000 €		Payback period	none
Conversion	1,500,000 €		Nett present value (x1000€)	< 0
Downtime	6 weeks		Internal rate of return	n/a







6.4.1

Adaptation to CO2 transport

Description of the retrofit option

A 110m dry cargo ship is adapted to transport liquefied CO2 gas by application of independent tanks of IMO type C. Diesel-electric propulsion is applied for fuel efficient sailing without compromising the stopping-ability of the fully-loaded ship in downstream direction.

Back ground of the MoVe IT business case

Large Rhine ship type is considered, sailing on the Rhine river between Rotterdam and Karlsruhe. Water levels are representative for the last 30 years. All cost components in the assessment are on a Western-European level.

Technical feasibility, technological maturity

The proposed modernisation option is based on available technology with regard to the tank system as well as the propulsion unit with the aim to obtain an economically feasible solution.

Bandwidth of the Gains/Investments and Effects

A sensitivity analysis has been performed, in which investment are varied (+10%, -10%) and fuel costs (+10% / -10%). The results can be found in the economic feasibility study of Deliverable 6.6.

Enabling conditions and boundaries:

Economic feasibility can only be achieved if the price of CO2 certificates reach a level of about 30€/ton. Further are CO2 pipelines to be considered as direct competitor.

Which actions to be undertaken :

As this option is economically not feasible at all, no advise is given about actions that are to be taken. For technical information, please read Deliverable 6.6.

Applicability to other ship types

The application of independent liquid cargo tanks is is technically feasible regardless the size of the vessel. Preferably dry cargo ships as for tankers

More Information:

- Please read MoVe-It Deliverables 6.6.
- Contact: Erwin van Heumen, DST, +49 203 99 369 51 heumen@dst-org.de

Lessons Learned

Lesson 1: "Scale enlargement by means of conventional hull lengthening can make small inland ships more effective."

For that reason many smaller inland ships were lengthened during their lifetime. However, one should keep in mind that economic feasibility of lengthening is not trivial. The outcome of analysis strongly depends on operational conditions and investigated scenario. For such reason it is important to have thorough knowledge of the operational conditions and conduct a economic feasibility study before you decide to lengthen your ship.

Lesson 2: "Negative effects of climate change can be effectively compensated"

Application of adjustable propeller tunnel to the rather larger existing inland ships is a technically and economically feasible option to effectively compensate the negative effect of climate change. For smaller, and thus less low-water sensitive, ship types is operation as coupled convoy an effective measure.

Lesson 3: "Adaptation to CO2 transport is at the time economically not feasible"

Transport and storage of liquefied CO2 is technically feasible. However, as long as the prize of CO2 emission certificates is far lower that 30€/ton is adaptation of existing inland ships to transport liquefied CO2 gas economically not feasible.

Colophon

For more information about New Scales & Services

Please contact:

Dr. Igor Bačkalov, Dipl.-Ing. MRINA
Assistant Professor

Department of Naval Architecture
Faculty of Mechanical Engineering
University of Belgrade

Kraljice Marije 16
11120 Belgrade 35, Serbia

T: +381 11 3229 281
F: +381 11 3370 364
E: ibackalov@mas.bg.ac.rs

For more information about the collaborative project or one of the work packages

Please contact:
Project Leader MoVe IT!

Mr. Meeuwis van Wirdum
MARIN – Team IWT
Project Coordinator

P.O. Box 28
6700 AA Wageningen
The Netherlands

T: +31 (0)317 49 39 11
E: inlandship@marin.nl

www.moveit-fp7.eu

These guidelines are part of Move IT! dissemination

The guidelines are created by Erwin van Heumen, DST, on the basis of the work realised in the project.

Please contact:

DST - Development Centre for Ship Technology and Transport Systems
Department Transport Systems
T: +49 (0)203 99 369 -51
E: scholten@dst-org.de
P.O. Box 10 13 49
47013 Duisburg
Germany

Stichting Projecten Binnenvaart (SPB) lead Move-It dissemination. For questions on dissemination you can contact SPB through the project coordinator or directly via: b.kelderman@binnenvaart.nl