COMPETITIVE AND SUSTAINABLE GROWTH (GROWTH) PROGRAMME

HUMAN MACHINE INTERFACE

Working Paper

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1. INTRODUCTION

In recent decades various technical improvements, aiming at increasing the economic efficiency and competitiveness of inland navigation, have been introduced. In recent years the majority of changes have happened in the wheelhouse. These changes relate to the application of new devices, services and procedures being set up with increased logistic requirements. They mostly refer to information & communication technologies and other electronic navigational aids.

The introduction of a new procedures and/or new sophisticated devices is often accompanied with new or additional controls and displays which differ from previous 'conventional' ones. Sometimes the introduction of new devices is entirely technology driven without an underlying functional need. However, in a majority of cases, the aim of new solutions is to increase the efficiency and safety of the entire system. The crew on board is still unavoidable and remains a very sensitive part of the system. The essential goal to be achieved is that the new equipment reduces user workload. That is not always possible, because either an additional task for the skipper is provided (e.g. use of radar enables the safe navigation also under limited visibility conditions) or the man-machine interface is not optimally adapted to the user (e.g. inconvenient display design or controls layout).

In the situation with too much automation, permitting the skipper to intervene just occasionally, the risk of losing abilities to properly react in emergency cases with "manual" commands might occur. In other words, the high-quality man-machine interface should provide assistance and relief to the human operator, while at the same time keeping him always ready to react properly in any emergency situation.

The following paper attempts to give an overview of the inland navigation fleet and developments that influence the working place on board. The paper concentrates on dry and liquid cargo vessels forming the backbone of the fleet. With regard to the human machine interface the interaction between humans and equipment is elaborated. Personal protection is not looked at. Given the large scope of human machine interfaces the paper by no means claims to be complete.

2. OPERATION OF INLAND WATERWAY VESSELS

2.1 Description of the European fleet

The European inland navigation fleet consists roughly of self-propelled motor-vessels, push-tow units and a rapidly decreasing number of lighters (without propulsion). All may be carrying dry cargo in bulk and containers or liquid cargo in bulk. Furthermore there are a significant number of other vessel types, like dredgers, survey-vessels, heavy-lift barges, crane-barges, etcetera. These are however not considered in this report. Included are however specialist vessels like cement-tankers, wheat-tankers, pallet-vessels, which with regard to the working-place do not differ more from the main fleet than the difference between dry-cargo vessels and tankers.

Figure 1 Wheat vessel Mercurial Latistar

Figure 2 Pallet vessel Riverhopper

Table 1 provides an overview of the active inland waterway fleet in the EU (plus Switzerland) per 2002 as extracted from the Inland Waterways Observatory of the EC.

All vessels	Self-propelled dry cargo	Self-propelled tankers	Push-tugs	Pusher barges	Lighters	Total per country
Austria	8	8	6	81	22	125
Belgium	1103	197	95	171	6	1572
France	1063	50	25	230	4	1372
Germany	965	324	204	948	59	2500
Luxembourg	19	13	20	2	-	54
Netherlands	3221	700	539	971	144	5575
Switzerland	13	35	7	3	-	58
EU totals	6387	1345	896	2406	235	11269

Table 1 Overview EU inland waterway fleet

As it appeared to be difficult to find recent figures for the Danube fleet Table 2 provides data for the European fleet including the European part of Russia from the UN/ECE for 1992/1993.

	Number of vessels			Carrying capacity, thousand tons			Power, thousand kW		
	1980	1990	1992	1980	1990	1992	1980	1990	1992
Austria	214	232	225	195.8	257.9	250.2	46.1	44.4	41.7
Belgium	3,297	1,942	1,845	1,843.7	1,523.2	1,475.0	645.6	541.8	513.7
Bulgaria	-	-	274	-	-	370.6	-	-	-
Czech Republic	-	-	854	-	-	697.8	-	-	165.1
Finland	114	151	177	-	-	-	-	-	-
France	5,465	3,292	2,878	2,537.1	1,652.6	1,551.7	653.8	466.0	615.6
Germany	4,153	3,077	3,749	3,672.0	3,056.0	3,328.7	1,341.9	1,115.9	1,238.7
Hungary	280	246	249	241.4	236.4	251.2	33.3	39.0	34.4
Italy	2,564	3,127	3,127	-	-	-	-	-	-
Luxembourg	18	25	28	11.8	28.6	28.1	7.3	14.3	14.3
Netherlands	7,891	6,998	6,534	4,959.9	5,969.0	5,818.1	1,829.6	2,156.0	2,134.0
Poland	-	2,713	2,102	-	1,066.8	812.4	-	171.8	147.6
Romania	-	-	1,302[1]	-	-	1,329.9[1]	-	-	-
Russian Federation	-	-	12,219[2]	-	-	9,302.8[2]	-	-	2,863[2]
Slovakia	-	-	-	299.3	387.3	389.9	47.3	60.0	63.8
Switzerland	413	186	156	599.7	321.5	281.4	207.2	117.7	105.1
Ukraine	-	875	838	-	946.3	961.0	-	277.7	282.5
United Kingdom	-	721	830	-	171.5	205.0	-	56.6	69.0
Yugoslavia	1,244	1,139	-	761.2	741.9	-	100.7	118.8	-

1) Data for 1993
2) Data for European part of Russian Federation end 1993

Table 2 Overview European inland navigation fleet including Danube

	Rhine	Danube
Towed barges	2	27
Pushed barges	23	63
Self-propelled vessels	75	10

Table 3 Breakdown of Rhine and Danube fleet vessel types by their carrying capacity, % (1990)

Table 3 [1] shows that the share of self-propelled vessels differs greatly between the Danube and the Rhine fleet.

2.2 Ownership

Also the ownership differs greatly between the Danube and the Rhine fleet. Roughly 95% of the West European ship owners own 1 or 2 vessels with a majority only owning 1 vessel (or half a vessel, see below). Although figures are failing the indications are, that on the Danube larger shipping companies own most vessels.

Figure 3 Push-tow on the Austrian Danube.

Figure 4 Family operated

West European vessels are mostly operated by families with the crew consisting of husband, wife and depending on the mode of operation (14, 18 or 24 hrs operation) a mate and/ or one or more sailors. Mate and sailors most of the times are employees, but every so often they are the sons or daughters of the owner. In former days and even now these families would hardly leave their vessel. Even holidays very often are spend on board, the vessel being tied up or anchored at a nice location and holidays consisting of swinging, day-trips by car and some light maintenance. However an increasing amount of private owners also own a house ashore and weekends and holidays are at the house respectively abroad. Although during the weekends usually the vessel will be left alongside somewhere, during holidays the larger vessels (from 85 – 110 m length) usually will be operated by a relieve skipper to keep the flow of income going.

Figure 5 Family operated

The increasing amount of West European vessels that have a 24 hrs operation, more and more are owned and operated by two families, which alternate service on the vessel usually every two weeks. On the other hand the crew of most vessels that are owned by larger companies, both on the Rhine and the Danube are non-related employees. Many of these vessels have a 24 hrs operation, unless the sailing area does not allow such. Occasionally however, also husband and wife and some employees man these vessels. Such vessels may have a 14 or 18 hrs operation mode.

2.3 Mode of operation

The following modes of operation are distinguished Rhine [2]. These requirements are in line with the UN/ECE guidelines 'Minimum Manning Requirements and Working and Rest Hours of Crews of Vessels in Inland Navigation' [3]. Apparently the UN/ECE guidelines have not yet been implemented on the Danube:

Operation mode	Max period of operation/ 24 hrs:
A1	14
A2	18
B	24

In operation modes A1 and A2 vessels have to interrupt operations for 8 respectively 6 continuous hours:

a) Operation mode A1 between 22:00 and 06:00
b) Operation mode A2 between 23:00 and 05:00

These period-of-the-day limitations do not apply if vessels are fitted with a type-approved and properly functioning tachygraph.

It will be clear that prescribed crew numbers and licenses depend on the mode of operation of a vessel.

3. THE WORK PLACE

3.1 Considered workplaces

The work on board of an inland navigation vessel can roughly be divided into the following categories with the accompanying workplaces:

Navigation/ manoeuvring	Wheelhouse
Mooring/ unmooring/ formation/ anchoring	Deck
Cargo-handling	Deck Wheelhouse Engineroom
Household	Accommodation
Maintenance	Deck Engineroom
Administration	Wheelhouse Accommodation

None of the above-mentioned workplaces is standardized, although there is some standardisation of elements of the wheelhouse. Some of the reasons for this lack of standardisation are:

- the wide variety of ship sizes
- the lack of series-building in inland navigation
- the individual ownership
- the variety in employment of the vessels

Figure 6 Wheelhouse

This report will briefly describe the workplaces Deck and Engineroom, but will concentrate on the workplace Wheelhouse.

3.2 Deck

Both the Danube guidelines and the Rhine technical regulations [2] contain requirements with regard to workplaces on deck. These requirements deal with:

- Protection against skidding
- Marking of bollard tops and obstructions
- Available horizontal room
- Railings
- Width of gangway (passageway)

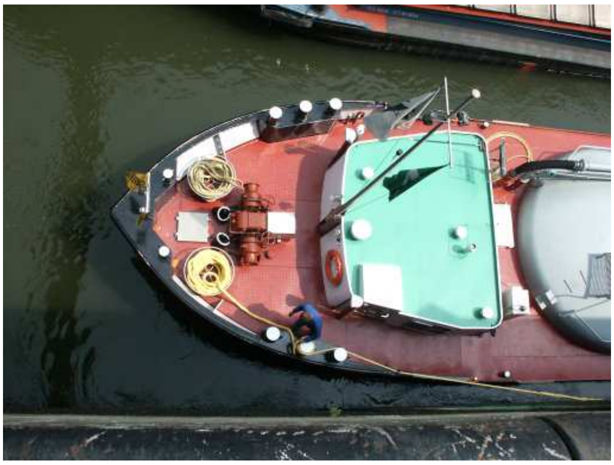

Figure 7 Fore deck of cement tanker Erasmusgracht

Apart from technical requirements with regard to strength, etc, there seems no regulations with regard to standardisation of bollards, anchor and rope winch interfaces. On the other hand the Western European inland fleet does show some voluntary standardisation with regard to bollards. Generally bollards are much larger relative to the mooring rope diameter than on sea-going vessels and ropes are put on one bollard only (See Figure 8). This principle allows much safer and faster rope handling than the bollard concept that is used on seagoing vessels. Also in practise there appears no standardisation with regard to the human interface of winches.

With regard to loading and unloading ISO provided a standard for draught scales [6].

3.3 Engineroom

Figure 8 Engineroom mv Va Banque

Not unexpectedly there are a great number of technical requirements with regard to the engineroom. Given the enormous variety of engines and equipment there are no requirements with regard to the human interface apart from maximum noise levels and some basic requirements with regard to alarms. With regard the human interface of alarms there is a minimum requirement with regard to loudness relative to the ambient noise level in the engineroom and a requirement for an optical indication of alarms when the noise level in the engine room exceeds a certain value. Finally ISO published standards [4][5] regarding the colour coding of pipelines and colours of indicator lights [7]. The pipe colour standards however do not seem widely used on inland vessels.

3.4 Wheelhouse

The wheelhouse is the one workplace where there are quite a number of regulations in the Rhine regulations and Danube and UN/ECE guidelines regarding the human interface as of now. These regulations deal with:

- Unobstructed view
- Operation of the engine telegraph
- Rudder indication
- Radar operation interface and radar display
- Inland ECDIS Standard
- Light level of (some of the) instruments

Figure 9 Navigation desk ms Taling

Also ISO published some standards that relate to human interface and wheelhouses in inland navigation:

- ISO EN 1864:1997 Inland navigation vessels - Wheelhouse and control position- Types, safety requirements
- ISO 2412:1982 Shipbuilding - Colours of indicator lights

The technical Rhine regulations [2] contain the following general requirement with regard to the wheelhouse:

Quote

Article 7.01 General

1. Wheelhouses shall be arranged in such a way that the helmsman may at all times perform his task while the vessel is under way.

(…)

3. Where a wheelhouse has been configured for radar navigation by a single person the helmsman shall be able to accomplish his task while seated and all of the display or monitoring instruments and all of the controls needed for operation of the vessel shall be arranged in such a way that the helmsman may use them comfortably while the vessel is under way without leaving his position or losing sight of the radar screen.

Unquote

3.4.1 Unobstructed view

Figure 10 View ahead

The regulations require an unobstructed view in all directions, where unobstructed should not be taken literally. An important part of the unobstructed view rule is the requirement that the area of obstructed vision for the helmsman ahead of the vessel in an unladen state with half of its supplies but without ballast shall not exceed 250 m. Interestingly there is no consensus in Europe with regard the use of auxiliary optical devices to fulfil these requirements. A recent study [8] by the Dutch Transport Safety Board concluded that quite frequently the 250 m rule is not adhered to and that auxiliary devices are not suited to compensate an obstructed view. Nevertheless

Figure 11 Side mirror

a recent attempt to exclude the use of auxiliary optical devices for this purpose in the Netherlands was met by heavy opposition of the inland waterway community, as it would seriously hamper the transportation of containers by existing smaller vessels (Kempenaar size).

Especially on the larger West European vessels mirrors (Figure 12) and/ or cameras (Figure 10) are used extensively in order to observe activities of the crew on fore and aft deck and the clearance of the side of the vessel.

3.4.2 Engine telegraph

Apart from technical requirements for back-up control in case of electronic remote control of the engines the regulations require the telegraph to be aligned with the ship's longitudinal axis and a forward movement of the telegraph lever should result in ahead propulsion. Furthermore there is a requirement that the operation angle from neutral to maximum engine output should not be more than 90°. Clutch engagement and reversal of the direction of travel shall take place about the neutral position of that lever. A clearly audible click shall indicate that neutral position.

Figure 12 Engine control mtv Va-Banque

With the advent of azimuthing propulsion combinations of rudder and engine tillers were developed (see Figure 13).

Figure 13 Azimuth propeller control

Figure 14 Rudder control

3.4.3 Rudder control

Given the average age of inland vessels there are still quite a number of vessels that are fitted with a convention steering wheel. However even most of those vessels have a mechanical actuated rudder control as well. The steering wheel providing the required back-up option.

Figure 16 mv Addio

A number of vessels still have non-follow-up[1] rudder tillers. A non-follow-up tiller however increases the workload of the helmsman quite considerably compared to convention steering or to a follow-up[2] tiller since the only feed-back of the actual rudder position is from the rudder indicator or the behaviour of the vessel. Thus requiring a higher consciousness level. Therefore one-man radar operation requires a follow-up rudder control, which provides the more sub-conscious feedback of the position of the tiller. Generally the rudder tiller combines the function of direct follow-up rudder control and control of the usually installed rate-of-turn autopilot. Similar to the engine control lever a clearly perceptible click must indicate the neutral position of the rudder tiller.

Figure 15 mv Jenny

The rate-of-turn autopilot is one of the major improvements with regard to workload in inland navigation. A well-tuned rate-of-turn autopilot greatly reduces the amount of rudder control actions of the helmsman and allows the helmsman to concentrate on observation and decision-making.

It is interesting to see that the regulations do require the operation of the engine control to correspond with the direction of the (effect of the) propulsion, but only contain

[1] Non-follow-up: a deflection of the tiller initiates movement of the rudder. A neutral position of the tiller leaves the rudder in its present position.
[2] Follow-up: Tiller and rudder position correspond.

Figure 17 Wheelhouse hydrofoil Donaupfeil

a requirement with regard to the direction of operation of the tiller for one-man radar operation. In contrast with sea-going vessels however inland navigation en-masse has chosen for the tiller position to correspond with the rudder position.

On most twin-screw inland vessels the rudders behind the different propellers cannot be controlled individually. This has the advantage of a more simple installation and less to worry about, but does reduce the astern capability sometimes even considerably. For these reasons modern seagoing cruise-vessels usually do have individual control of the rudders and some are fitted with a device that automatically puts a rudder amidships if its propeller runs astern.

3.4.4 Flanking rudders, bow rudders

Vessels above 86 m length are required to be able to stop facing downstream in good time while remaining adequately manoeuvrable. For this reason especially pusher-tugs have been fitted with so-called flanking rudders in front of the propellers to maintain steerage with the engine running astern. Like the main rudders these flanking rudders are controlled with tillers, in this case usually individually. Also in this case the control one-man radar operation requires follow-up with the rudder moving in the same direction as the tiller. On more recently built pusher-tugs the flanking rudders are replaced by a bow-thruster for reasons of fuel saving.

Many of the push-tow barges are fitted with bow rudders to decrease the drift angle of the unit with side wind and in bends. Usually there is one tiller in the wheelhouse of the pusher-tug that controls these rudders simultaneously, again rudder and tiller position corresponding.

3.4.5 Bow-thrusters

Bow-thrusters are widely used on inland navigation vessels; mainly when manoeuvring, but also when underway. Many of the bow-thrusters in use have a 360° operation range. Although there is an increasing call for

Figure 18 mv Jowi


Figure 19 Bow-thruster controls

standardisation of the direction of operation of the controls, so far the skippers are divided in two camps: one who prefers to have the control position correspond with the direction of the propeller wash, the other who prefers to have the control position to correspond with the direction of movement of the bow. The regulations appear not to be clear in this respect, only requiring the thrust direction being clearly indicated.

3.4.6 Radar

Radar has been accepted as a primary navigation source in inland navigation much more and much earlier than in the maritime world. As a consequence the regulations regarding the radar in inland navigation include some vital additions with regard to accuracy and - most importantly - the human interface. On a functional level these requirements deal with among others:

- Controls that allow the use of motor-memory
- Head-up display to achieve correspondence with the outside world
- Standardisation of ranges and range-rings to avoid confusion
- Rate-of-turn indicator to allow early recognition of course deviations and to allow controlled turning

Figure 20 mpv Gutenberg

For one-man radar operation:

- Optimised location of display unit and rate-of-turn indicator in front of helmsman
- The radar image to be perfectly visible, without a mask or screen, whatever the lighting conditions applying outside the wheelhouse
- All vital vessel functions within hand reach of the operator (conning skipper)

3.4.7 Inland ECDIS

Almost all new-buildings and many of the existing vessels in inland navigation – at least in Western Europe – are being equipped with electronic chart systems. Since the adaptation of the Inland ECDIS Standard [9] by the CCNR, the Danube Commission and the UN/ECE in 2001 almost all manufacturers of electronic chart systems that are active in the European inland navigation market have adapted their software to read Inland ENCs, i.e. chart data according to the Inland ECDIS Standard. The Standard recognises two modes of operation of an Inland ECDIS system:

- Information mode
- Navigation mode

Information mode is an Inland ECDIS system without a radar-overlay. The information mode was introduced to allow an easy transition to Inland ECDIS systems from the proprietary electronic chart systems that were in use before the Standard. Only recommendations apply to information mode systems.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Figure 21 Information mode: Tresco Viewer

Navigation mode, which does include a radar-overlay, recognises the fact that in inland navigation position finding and collision avoidance cannot be separated. It is therefore hoped for and actually expected that ultimately all vessels will have navigation mode. However given the rather steep price level of the present navigation mode systems a transition period was needed. In navigation mode the Inland ECDIS display may replace the radar display entirely and therefore all radar regulations also apply to the navigation mode.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Figure 22 Navigation mode: RadarPilot 720°

3.4.8 Other software applications

A number of software applications have entered the wheelhouse of inland navigation vessels in the last decade apart from the previously mentioned electronic chart systems:

- Loading software (e.g. Bayplan 2000, ContainerPlanner, MIDAS, GAUGE-03, IJKEN)
- Voyage planning software (e.g. PC-Navigo)
- Fuel optimising software (e.g. Tempomaat)
- Voyage reporting software (BICS)

- Notices to Skippers software (BICS/BOS)

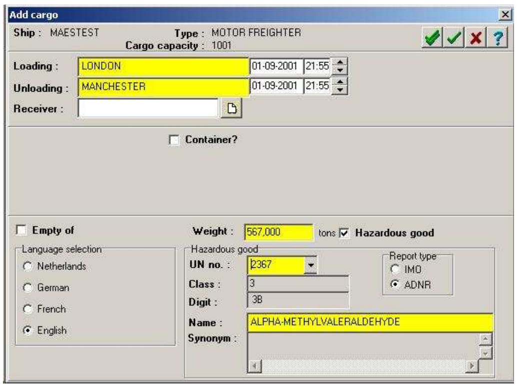

Figure 24 BICS electronic reporting software

- Fax software, web-browser, email software
- Etc

Part of this software will only be used when the vessel is tied up alongside. Others, however, are (also) used when the vessel is underway. In most cases these applications run on another PC than the electronic chart system.

- Information Dangerous Goods (e.g. BICS/BAS, BIG)
- Virtual marketplace software (e.g. BargeLink)
- Cost price calculations (e.g. ProfiPlanner)
- Maintenance planning (e.g. Marad® Lite)
- 2-wire system monitoring and control applications (e.g. NETmate)
- Bookkeeping software

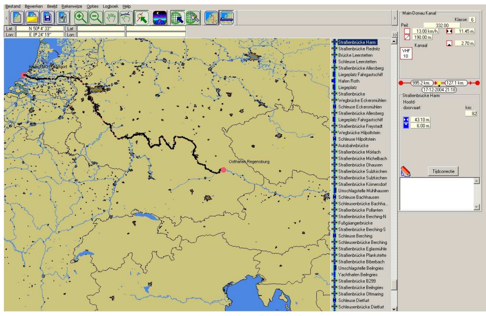

Figure 23 PC Navigo voyage planning

3.4.9 General requirements concerning control, display and monitoring equipment

General requirements concerning control, display and monitoring equipment are:

- Equipment that is needed for the operation of the vessel must be easily switched on. The status of such equipment must be unambiguously clear.
- The monitoring instruments must be easily legible. It must be possible to adjust their lighting infinitely-variable down to their extinction. Light sources shall be neither intrusive nor impair the legibility of the monitoring instruments.
- There must be a system for testing the warning lights.
- It must be possible to establish clearly whether a system is in operation. If it's functioning is indicated by means of a warning light this shall be green.
- Any malfunctioning or failure of systems that require monitoring shall be indicated by means of red warning lights.
- An audible warning shall sound at the same time that the red warning lights light up. The audible warnings may consist of a single, common signal. The sound pressure

level of that signal shall exceed the maximum sound pressure level of the ambient noise at the steering position by at least 3 dB(A).

- The audible warning system may be switched off after the malfunction or failure has been confirmed. That shutdown shall not prevent the alarm signal from being triggered by other malfunctions. The red warning lights shall only go out when the malfunction has been corrected.

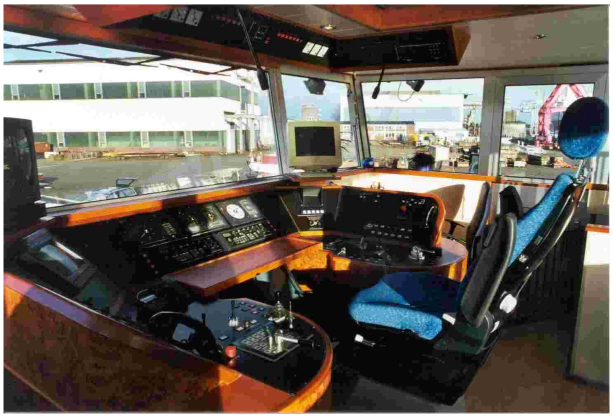

Figure 25 ms Aviso 1

Furthermore there are requirements with regard to (the design of) the indication of the status of the navigation lights, general alarm, heating, ventilation and for one-man radar operation intercom, foot operation of signal horns and remote operation of the stern anchor for vessels over 86 m length. The ISO EN 1864:1997 standard also contains requirements with regard to reach ranges of the different controls, instruments and indicators.

3.4.10 Communication

On a number of inland waterways nowadays two VHF-sets are required. For one-man radar navigation it is required that these VHF's avail of a fixed microphone and transmission push button. Also the reception of traffic warnings must be easy to hear from the helmsman's position. Furthermore almost all ships nowadays have one or more GSM sets on board, either permanently installed and/or handheld. It is not uncommon that at a given moment there are half a dozen GSM's in the wheelhouse: e.g. two permanent ship's sets and a number of personal handhelds of the different crew members. On top of that usually there will be a radio receiver for public broadcasts fitted in the wheelhouse and in many cases even a television set.

Figure 26 VTS centre Nijmegen

4. DEVELOPMENTS

4.1 Social-economic developments

A number of social-economic developments in inland navigation are relevant in the context of this report:

- Scaling-up of vessel dimensions and phasing out of smaller vessels
- Social changes
- Enlargement of the EU

Figure 27 bunker vessel mtv Vlissingen

4.1.1 Up scaling of vessel dimensions

One of the effects of the first mentioned development is a renewal of the fleet and thus the workplaces on board. Especially the private ship owners appear to be willing to invest in a very comfortable and even luxurious living quarters, including the workplace in the wheelhouse as is shown by some of the pictures in this report[3]. This is not that surprising when one takes into account the number of hours that is spent in the wheelhouse.

4.1.2 Social changes

Almost all private owned inland vessels nowadays have a car-crane and one or two cars on board. This has greatly improved mobility outside the vessel. The relevant social changes that are relevant in the context of this report largely consist of the earlier mentioned tendency of the private owners not any longer to stay on board all

Figure 28 Car crane

[3] The larger shipping companies generally take after a more basic interior and workplace design.

year, but to spend part of the time ashore to run the business and also take regular holidays. The vessels that have a 24 hrs operation generally have a regular full relieve crew. The vessels that operate in 14 or 18 hrs however generally use fee-lance personnel.

One of the characteristics of inland navigation that ship operators were very familiar with the vessel they were sailing on is therefore changing to a situation where personnel changes ship more often. Such a development does increase the need for standardisation of the workplaces.

4.1.3 Enlargement of the EU

The recent enlargement of the EU has resulted in or has accelerated two developments:

- Increased inflow of Eastern European personnel to the Western European fleet
- Increased share of Eastern European fleet on Western European waters and vice versa.

Figure 29 Dutch pusher on Austrian Danube

The first development may increase the previously mentioned development of rotating personnel although not necessarily. Both developments have the effect of less local knowledge at least for the time being. Another effect is a temporary language problem.

4.1.4 Local knowledge

Especially the certification of navigators on the Rhine has and still does put a strong emphasis on local knowledge (Fahrstreckenkenntnis). The expansion of the sailing area of inland navigation however will make it impossible to keep up local knowledge throughout this area and calls for other solutions like detailed electronic charts and voyage planning software applications.

4.1.5 Language

With regard to language, for many years language has not really been an issue in inland navigation. Skippers tend to operate in one specific and restricted area and learn the basics of the relevant language(s). For example a German skipper (and his mate) who usually navigates the Rhine into the Netherlands speaks sufficient Dutch to make himself out in the

Netherlands. A Dutch skipper of a peniche sailing to France will/ has to learn to speak sufficient French to get around. Only at times of changes in the market with groups of vessels moving into new sailing areas language temporarily poses some problems. For example some 20 – 15 years ago the French peniches enlarged their area of operation into the Netherlands and for the first years communication was rather difficult.

Figure 30 Peniche at Strepy

In recent years mostly outsiders have been calling for English to become the standard language in inland navigation, one of the arguments being the supposed use of English in the mixed areas of maritime ports. This argument however is badly chosen given the general reluctance of maritime pilots to give up their mother tongue and the continuing minimal knowledge of the English language among seafarers.

English has penetrated into most European languages and has been established as the first choice language for international communication within Europe. When listening to one's children, one sometimes questions the future of the national languages. With regard to inland navigation it seems more relevant to put pressure on national television networks to refrain from dubbing movies in the national language but use sub-titles instead than (prematurely) imposing the use of English on the sector.

In the mean time inland navigation software application builders appear to have been adapting their applications to the new arising markets. For example the Tresco Viewer is now available in all Rhine and Danube languages. Also one of the aims of the standardisation of the Notices to Skippers by the NtS expert group is to allow simple translation of the notices into the different European languages. Furthermore the e-learning language tool that is being developed within COMPRIS will assist in dealing with existing language barriers.

4.1.6 Cross border traffic and transport information

Even with the expansion of the EU and the Schengen Treaty inland navigation is still being confronted with borders. Borders that usually all have different procedures, forms, etc as well as sometimes considerable waiting times. Therefore an initiative like the one of COMPRIS work package 6 'Cross border traffic and transport information' is most welcome. The COMPRIS initiative in close co-operation with the ERI working group [10] appears to be most successful in getting all the different authorities that are involved in cross-border traffic around the table to work standardised and electronic cross-border procedures.

4.2 Technical developments

In 2002 the Agency for Telematics in Inland Waterborne Transport (BTB) distributed a very educational booklet [11] with stories about how the work on board of a future inland vessels might look like. Unfortunately the booklet is only available in Dutch.

A number of technical developments are relevant for the wheelhouse workplace on inland navigation vessels. These are among others:

- Digital observation and control systems
- River Information Services
- Tracking & tracing
- Wheelhouse location
- Steering control

4.2.1 Digital control and observation systems

Digital (2-wire, bus) systems are increasingly taking over both observation and control of operational systems on board of inland vessel new-buildings. Important advantages of digital systems are a significant reduction of wiring and thus cost and maintenance and major gains in the human interface of the status and controls of all systems.

However regulations clearly have not been able to keep up with these developments. Attempts to introduce regulations in this area appear to be mostly hardware related, where the experience – including the experience from the maritime world - shows that problems may be expected to be mostly software related and partly due to the Microsoft dominance where it concerns PC operating systems.

Interviews with manufacturers indicate that some sort of reliability can only be achieved with dedicated and completely closed systems. Experiences in the maritime world and aviation indicate that if PC's are involved only custom built Unix/ Linux environments can deliver ultimate reliability. Until then hardware failures will

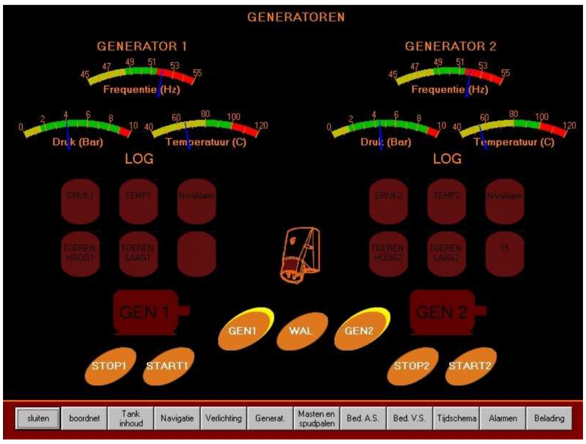

Figure 31 NETmate Databus display

have a much lower likelihood and usually can be remedied more easily.

In the mean time users, IT departments and developers alike are used to/ demand Microsoft environments. The effect is a ‘white elephant’ situation where any requirement to refrain from the use of main-stream operating systems to enhance reliability and thus safety would result in developers moving out of the market and thus a very likely total stall of development.

4.2.2 River Information Services

The EU project INDRIS proposed the introduction of so-called River Information Services (RIS) to enhance information flows in inland navigation. RIS is being worked out further in the EU project COMPRIS and expert groups like ERI, Arbeitsgruppe Telematik, Inland ECDIS expert group, NtS expert group, etc [10]. Presently a draft proposal for a European RIS Guideline is being discussed in the Commission and the European Parliament.

The RIS Guideline may be expected to boost developments with regard to:

- Inland ECDIS
- Standardised Notices to Skippers
- Electronic reporting
- Voyage planning
- Advanced lock planning
- Reduction of paper forms
- Electronic exchange of logistical data
- Tracking & tracing
- E-learning

Figure 32 mpv Ybbs negotiating an icy Danube

Many of the software manufacturers that are active in the inland navigation market are participating in the different expert groups and the COMPRIS project. This ensures a strong link between R&D and implementation.

Clearly the process of shifting away from paper forms, notices to skipper, chart, etc puts much more emphasis on the use of PC’s on board. With regard to the human interface it will however be a major challenge to compensate for the fact that even on a modern inland navigation vessel work is not the average office job and that even a modern inland vessel’s wheelhouse is not the average office environment.

4.2.3 Inland ECDIS

Within RIS Inland ECDIS is supposed to become more than just a replacement of the paper chart. In the end all geographical related data is supposed to finds its way into the inland ENCs. The draft European RIS guideline contains a requirement to provide Inland ECDIS coverage of all CEMT class V and higher waterways. At present however apart from Austria who has full ENC coverage of its part of the Danube all European countries are struggling to get ENC coverage. A serious set-back is that given the financial position of a number of the countries it appeared not be possible to get agreement on including a requirement for coverage of CEMT class IV and higher let alone coverage of all inland navigation waterways. Still by far the larger part of the voyages of inland navigation vessels includes minimally also Class IV waterways. As such Inland ECDIS for quite some time will depend on private initiatives of commercial manufacturers to provide most of the needed Inland ENC coverage. Fortunately some companies have met this challenge and as such more or less saved the introduction of Inland ECDIS, which otherwise would have been a total failure. Nevertheless it is very regrettable to see that requests and offers off these companies to co-operate with official bodies get access to the official source data and to provide a swift coverage by official ENCs is hardly awarded. Also it is sad to note that some authorities have been discussing for over two years now the legal aspects of making very valuable and much needed existing official (Inland) ENCs available to the users.

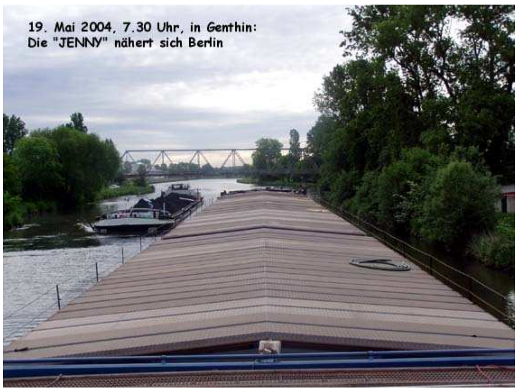

Figure 33 mv Jenny, Mittelandkanal

On the other hand the COMPRIS project has delivered some very innovative proposals to enhance the Inland ECDIS Standard, among others a solution for time related information and the Legal ECDIS concept. The first allows including the sometimes very complicated operational time schedules in the Inland ENC. The latter is a concept to include all the different local regulations into an ENC. Also within COMPRIS a co-operation with the North Americans and Russia was started aiming to draft an International Inland ENC Standard. This initiative has resulted in the establishment of the Inland ENC Harmonisation Group (IEHG) and in the International Hydrographic Organisation to take the Inland ECDIS developments serious, a vital development for a continued compatibility with maritime ECDIS.

4.2.4 Voyage planning

It will be very difficult to improve on the planning that many of the inland waterway skippers make by heart by means of voyage planning software. Also one of the vital inputs for the planning of a slightly longer inland navigation voyage very much depends on the prediction of the river water levels. Especially in this area only very modest progress has been made.

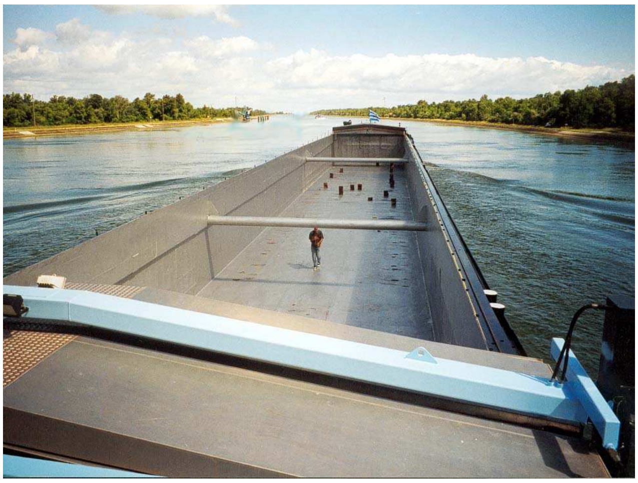

Figure 34 Underway to a new cargo

Nevertheless two developments will make the voyage planning application one of the more important applications in the wheelhouse:

- The enlargement of the EU and resulting expansion of the sailing area of inland navigation (see also § 4.1.4).
- Developments with regard to electronic reporting with an increased role of the voyage plan of all vessels.

The latter development will require detailed voyage plans of all inland navigation vessels in future. Although in theory one would be able to deliver such a plan without voyage planning software, but this would be quite cumbersome.

Unfortunately the role of the voyage planning software is seriously hindered by the lack of official ENCs of most of the European waterways requiring the voyage planning software manufacturers to continue their struggle to gather the relevant data for the voyage planning application (see also § 4.2.3).

4.2.5 Lock planning

Enhancement of lock planning was already elaborated in INDRIS. In the mean time the German MOVES system has been set up on the River Mosel. MOVES aims to provide vessels with advanced information on waiting times at locks and to offer the option to save fuel by proceeding towards a lock at a reduced speed. Furthermore in Belgium enhanced electronic reporting and in France tracking & tracing (AI-IP) experiments aim to enhance lock (and bridge) planning.

Figure 35 Irene locks, Netherlands

In COMPRIS research into the subject of lock planning involves both increasing the information at the lock by means of enhanced voyage plans (see § 4.2.4) and providing detailed average waiting time statistics to the voyage planning application. The latter information would enhance the accuracy of voyage plans considerably. However given the struggle to get coverage by official ENCs one may have some doubts on the pace with which such statistical data on locks would be made available.

4.2.6 Tracking & tracing

Tracking and tracing is probably best know in its shore applications, for example the tracking and tracing service that is provided by parcel mail companies like UPS. Tracking and tracing in inland navigation has two aspects. One aspect has to with navigation and traffic monitoring. The other aspect is more logistical related, ship- or cargo owners wanting to track and trace vessels and/or cargo.

Early applications of tracking and tracing in inland navigation are the Dutch IVS'90 and the German MIB system, both mainly aiming to track and trace vessels carrying dangerous goods for calamity abatement purposes.

In the EU project INDRIS the maritime AIS transponder was proposed as a technical solution first and for all to provide additional information on other vessels on the radar/ ECDIS. A cost/ benefit evaluation however showed that although safety may be enhanced somewhat the return on investment would be negative.

A potential other use of AIS seemed to be to provide tracking and tracing services for vessel traffic monitoring and logistical purposes. This however requires not only the vessels being equipped with AIS transponders, but also a (dense) network of shore-based AIS stations[4].

Discussions within the sector on the subject of tracking and tracing are not yet concluded at the writing of this report. So far however the discussions seem to indicate that the sector does see advantages in the additional navigational information, but has concerns about the human interface. The sector seems positive about sharing tracking and tracing information with authorities for traffic monitoring purposes, but in general has major privacy and commercial concerns:

[4] Austria having only 350 km of Danube is testing this option in the DoRIS test centre. On the other hand Germany and France having a waterway network of several thousand kilometres have expressed not to be willing to make such investments.

- On about half of the inland navigation fleet families are living on board.
- The whereabouts of the entire inland fleet being in the public domain would have serious effects on the market position of the owners.

The increased focus on security aspects further highlights these concerns especially in relation to the AIS technology[5]. One would think that inland waterway transport being the preferred transport mode for highly sensitive cargos like ammonia and LPG is in conflict with tracking and tracing information being available to anyone at any time.

On the other hand the inland navigation sector realised that most of the previously mentioned developments would result in an increased demand on reliable and cost-effective mobile communication, with especially the latter so far failing. The sector also realised that to for a strong negotiation position differentiating communication techniques for different purposes should be avoided. At the same time the development of network based mobile communication like GPRS, UMTS and broadband two-way satellite communication led to the reflection that it must be feasible to extent tracking & tracing systems towards monitoring of vessels/traffic in inland navigation. The difference between tracking and tracing and monitoring for traffic management and navigation purposes seems to be mostly limited to the update rate. Therefore a network-based solution, which has been called AI-IP, offers an alternative to AIS. AI-IP mimics AIS functionality except that it does not use its own infrastructure, but is based on already existing public communication infrastructures and standard technology equipment (also known as Customer Premises Equipment) using standard IP-protocols and can be made fully secure.

As yet the outcome of the discussion is unclear. On the one hand authorities seem to have a rightful demand for an increased insight in the whereabouts of the inland fleet. Also where nowadays many road transport companies use tracking and tracing both for internal purposes and as a service to their clients it seems likely that some form of tracking and tracing will find its way into the wheelhouse of inland vessels. On the other hand one would expect the privacy and commercial interest of inland navigation getting similar protection to the privacy of any European citizen and the commercial interests of any other European company.

4.2.7 Logistical data exchange

Notwithstanding the discussion on which system to for tracking & tracing it is clear that there is a need in the inland waterway transport sector for increased electronic data exchange in the area of logistics. One existing initiative is the electronic market place Bargelink where cargo owners can search for vessels and vessel owners can search for cargo. Another initiative is the freight bulletin board Vaart!Vrachtindicator that aims to give skippers/ ship owners insight in current freight levels. Experiments with an electronic bill of lading are made in the Dutch Paperless sailing project with pilots also in COMPRIS. Also in COMPRIS the BoRIS web application assists cargo owners to decide how to transport a specific cargo lot to a certain location using inland waterway transport. Finally the Arbeitsgrupppe Telematik [10] is developing standards for electronic logistical data exchange messages including billing of freights.

Figure 37 ARGO track pilot display

4.2.8 Track pilot

The earlier mentioned navigation mode Inland ECDIS system RadarPilot 720° was initially developed by the University of Stuttgart as part of a control system study into automated track following of inland vessels. The developed inland navigation track-pilot has been demonstrated in the German ARGO project and test applications are still installed on some inland cargo vessels.

The track-pilot is taking automation of steering a vessel one step further than the earlier mentioned rat-of-turn pilot. With the track pilot the track of the vessel is controlled: rudder actions and turning behaviour are left to the application. In the ARGO version the application automatically derived a track from the data contained in an ENC (ECDIS chart database). The skipper then has the possibility to set an off-track distance if he wishes so. Also collision avoidance takes place by setting an offset to the track, unless it is decided to take over control and switch to manual steering.

From a technical point of view the track-pilot is quite challenging and interesting. However from a practical point of view the track-pilot must be seen as an undesirable development.

First of all fortunately only occasionally skippers already nowadays rely on the rate-of-turn pilot to leave the wheelhouse

[5] AIS is inherently open for everyone as is demor
aislive uses actual AIS shore-stations any cheap
demonstrated on the site rl.se.

momentarily. A track-pilot will be very tempting at night when one has not met another vessel for quite some time and needs to go to the toilet urgently. The experience in the maritime world has regrettably shown that a dead-man's alarm does not remedy such behaviour. An empty wheelhouse is of course the more extreme consequence. More often however people not having to pay much attention to the track keeping of the vessel, will get (fully) occupied by other activities like reading, administration, etc., a sad experience from numerous maritime accidents.

Figure 38 track-pilot controls

Another very relevant reason is the different behaviour when meeting other vessels. Passing distances are frequently very small (≤ 10 m) on inland waterways and it is common practice that vessels during a meeting actively navigate 'around each other' manoeuvring especially the stern of the vessel actively to make room for the other vessel. The control over a vessel that is steered by a track-pilot is more indirect and other vessels may have unpleasant surprises finding a track-piloted vessel not making room when it was expected to do so.

Finally the human interface of the ARGO track-pilot consisted of a hardware control panel while in the ECDIS display the track as well as the offset-track in case the skipper put in an offset, were displayed. This extra information appears to potentially overload the display; During one of the trials it was witnessed that for about half an hour a penich was fully covered by these lines and thus invisible on the display.

These arguments lead to the conclusion that the track-pilot is taking automation one-step to far: Safety requires the skipper/ helmsman to stay actively involved in the navigation process. The rate-of-turn pilot appears to do just that.

4.2.9 Wheelhouse location

Figure 39 Frontrunner

By far most inland vessels have the wheelhouse at the back end of the vessels. The original reason for having the wheelhouse aft was the reason that the rudder was aft. Over the years there have been some vessels with the wheelhouse forward, e.g. numerous passenger vessels and some cargo vessels, usually to enhance the view forward. Presently especially the container transport introduces a new motivation to position wheelhouses forward and a number of vessels have been built in such way. Clearly having the wheelhouse forward improves the forward view greatly in the case of the cargo obstructing the view from aft. However there are also significant disadvantages. The most important one is the greatly reduced ability to monitor heading and heading changes. Many seagoing supply vessels demonstrate the importance of this disadvantage. When these vessels also having the wheelhouse at the bow, have to pass a narrow lock they will usually do so going backwards. Similarly with the increasing dimensions the very large seagoing cruise vessels that are built at Meyer Shipyard on the River Ems in Germany are now travelling the 60 kilometres from the yard to sea backwards, the visuals simply failing the required accuracy when moving forward[6].

Figure 40 Serenade of the Seas on the River Ems

Inland vessels are very frequently in confined situations, either due to a restricted infrastructure (river, canal, locks, bridges) or due to traffic and are confronted with this disadvantage every day. Like with the track-pilot the wheelhouse position does not only have an effect on the vessel itself, but also on others. Other vessels will have to keep a larger distance to vessels with the wheelhouse forward due to the less accurate movement of the stern of those vessels.

Another problem appears to be the position of the navigation lights on a number of the vessels with wheelhouses forward. Usually the red and green navigation sidelights are positioned aft on inland vessels with only the top light being in the fore mast. Many of the new ship types with the wheelhouse forward however appear to have both top light and sidelights forward. Not only does this result in other vessels being seriously hampered in their possibilities to judge the vessels track, but also they are confronted with a vessel of which the larger part is unlit and thus appears to be much larger than indicated by the navigation lights.

A number of accidents have happened with small vessels being overrun by inland vessels in some cases involving fatalities. On the other hand as has been explained pre-

Figure 41 Neokemp

[6] Even though the primary navigation information is

viously positioning the wheelhouse forward also has negative aspects with regard to safety. Therefore it would be very worthwhile to investigate the accident rate of inland vessels having the wheelhouse forward compared to those having the wheelhouse aft.

4.2.10 Lifting wheelhouses

Notwithstanding the movement of some ship owners towards forward wheelhouses most new vessels are fitted with lifting wheelhouses. A lifting wheelhouse greatly enhances the forward view, however, at the same time when lifted it reduces the view close to the stern ('blind zone') if no measures are taken.

Figure 42 Lifting wheelhouse mpv Ybbs

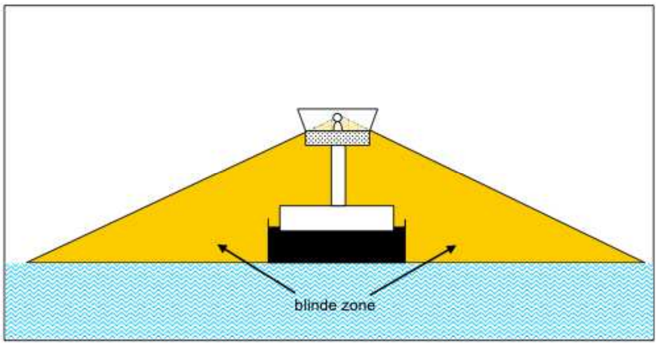

Figure 44 Blind zone

There is a direct relation with the width of the wheelhouse, the wider the wheelhouse the lesser the view next to the stern from the helmsman's position. This pleads for narrow wheelhouses. On the other hand the wheelhouse plays an important role in the social life on board of many inland vessels. Not in the last place on board of the many family owned vessels. The wheelhouse as a point of gathering calls for a spacious wheelhouse. On most vessels the blind zone I compensated for by mirrors and or cameras. The compromise that is found on a number of vessels is a comprised wheelhouse width, glass panes in the lower half of the wheelhouse door and the earlier mentioned mirrors and/ or cameras. As was also recommended in [8]

Figure 43 Lifting wheelhouses

ship owners, designers and ship yards should be made aware of the effects of the wheel-house dimensions on the outside view of the skipper/ helmsman.

5. HUMAN-MACHINE INTERFACES

5.1 Fundamental knowledge

The previous chapters show that detailed regulations exist with regard to some off the human machine interfaces. On the other hand there appears to be very little fundamental research or research at all into the tasks and behaviour of inland skippers and requirements with regard to the human machine interface that could provide guidance for the manufacturers and policy makers. The lack of fundamental knowledge opens the risk of haphazard and possibly wrong regulations. Such risk until now was dampened by the fact that policy makers often had a practical background. Presently however this generation of policy makers is retiring rapidly and their replacements usually do not have this practical background.

However even a practical background is no guarantee for fundamentally sound solutions for the human machine interface. Fundamentally sound solutions can only be attained by fundamental research that has abundant practical input. The next paragraphs will therefore show examples where the co-operation of skippers, designers and manufacturers led to great solutions. However the next paragraphs also show examples of faulty solutions. Very often the latter were mainly technology driven.

5.2 Present situation

5.2.1 Wheelhouse software applications

Even though the spread of PCs on board compares very well and in some countries even favourable to the situation in comparable businesses ashore, still there are quite a number of vessels that either do not have a PC on board or do not have a PC in the wheelhouse. The spread of PCs is however increasing very rapidly even on the smallest vessels.

On the most up-to-date vessels the PC and PC display setup in the wheelhouse usually consist of one dedicated PC for the electronic chart most of the time in information mode and possibly combined with a voyage-planning module. Especially on new-buildings navigation mode i.e. radar combined with ECDIS, is gaining terrain. Another dedicated PC runs and displays the digital control and observation system. Finally yet another PC provides loading software, electronic reporting and notices to skippers software, etc.

Not surprisingly the displays of the first two PCs are positioned at the steering position. The last PC with the more strategic applications is usually positioned at a desk at the side of the wheelhouse.

Figure 45 mtv Alpeus passing a low bridge

As was mentioned in § 4.2.2 already the process of shifting away from paper forms, notices to skipper, chart, etc will put much more emphasis on the use of PC's on board. With regard to the human interface it is however a major challenge to compensate for the fact that even on a modern inland navigation vessel work is not the average office job and that even a modern inland vessel's wheelhouse is not the average office environment.

In the wheelhouse the user may have just arrived back from handling ropes on deck with the outside temperature being well below zero degrees. Generally in the wheelhouse the distance between the user and the display is significantly greater requiring much larger fonts. Both keyboard and mouse/ tracker ball usually are, to say the least, not optimally located, requiring a much more sophisticated text input preferably using lists and/ or making suggestions and corrections to the input of the user. Menu's and buttons need to be sufficiently large and very tolerant to more awkward cursor movement. Menus should be only one-level deep and should always be at the same location near the display border to allow a first rough positioning of the cursor based on muscle memory.

Not to impair the night vision of the skipper during the night the light level of the display of an application needs to be fully adjustable (see however also § 5.2.2). Also the colours that are used are important in this respect. Some colours conflict with night vision.

A number of the present software applications more or less adhere to these rules. However many do not.

5.2.2 Wheelhouse light level

There are rules in relation to the night vision of the skipper for a number of the light sources in the wheelhouse. For many sources there are however no such rules and the light level in many wheelhouses nowadays is such that for example the (dark) night display as prescribed for ECDIS is too dark for practical purposes. As a consequence if a poorly or unlit object does not show on the radar, it may very well not be detected at all.

The question is if the problem can be solved at all by providing rules for all light sources. Given the sheer number of light sources in a modern wheelhouse it might very well be the case that the sum of all individual sources at the lowest functional level, i.e. the level where the function of the light source is still available, is simply too high not to impair the night vision.

One thing is certain: The wheelhouse light level needs an overall approach.

5.2.3 Radar display

The inland navigation radar regulations are among the best with regard to the human interface. Very few regulations are as practical as the radar regulations. Unfortunately the regulations did not fully adapt to the change from the old fashioned CRT radar display tube to the nowadays common daylight/ rasterscan display.

When manoeuvring or during sharp turns afterglow of especially the return of the shore was quite often a nuisance on the old CRT radar tubes cluttering the radar picture. On the first generation of the new daylight displays this was even worse, sometimes leaving the display entirely useless for some time. Contrary to the old CRT tubes the daylight radars however provide an option to switch of afterglow at all and this is now the standard setting on almost all radars. The radars still do provide the option to switch on afterglow and even have the possibility to set the time-length of the afterglow. However if one would do a survey on the fleet one would find that on almost all vessels afterglow is switched off. Still on the latest daylight radars the afterglow has improved tremendously, now providing afterglow settings that are not obtrusive at all.

Figure 46 mv Philos overtaking on River IJssel

Afterglow provides important information for the skipper. To give some examples: in a bend a skipper can judge from the afterglow immediately if the ship has the required rate-of-turn. From the afterglow one can distinguish much earlier if another ship is going in the same direction or in the opposite direction as well as any course or speed changes such vessel makes. Afterglow also helps to make out faint echoes.

For these reasons the regulations should ensure that ‘afterglow on’ is the standard setting on inland navigation radars. Also radar-training institutes should make trainees properly aware of the value of and need for the display of the afterglow.

5.3 Present and future developments

5.3.1 Wheelhouse applications display

Already the EU project RINAC [11] realised that given the amount of information that in future would be presented via the computer one display would be insufficient (see also Figure 47). Also as will also have become clear from the previous chapters a distinction can be made between the short-term navigation (tactical) processes and the more intermediate and long-term (strategic) processes. Especially the first processes have a direct and immediate relation with safety. It is therefore very undesirable to allow any interference of the short-term navigation processes and interface from strategic processes and applications. When trying to pass another vessel in thick fog totally depending on the radar one would not want a pop-up window to cover the radar picture with a message regarding a change of the requested time of arrival at a lock.

Therefore only most urgent warnings that require immediate action from the conning skipper should be allowed on the short-term navigation display and even then only on the side of the display never to cover the immediate surroundings of the vessel.

As was described in § 5.2.1 nowadays developments actually have taken the RINAC concept one step further dividing the wheelhouse applications over three PCs. It appears that the pressure on the manufacturers by the skippers to provide reliability as well as the understanding of manufacturers that in some cases they may be accountable, has pushed developments in the right direction.

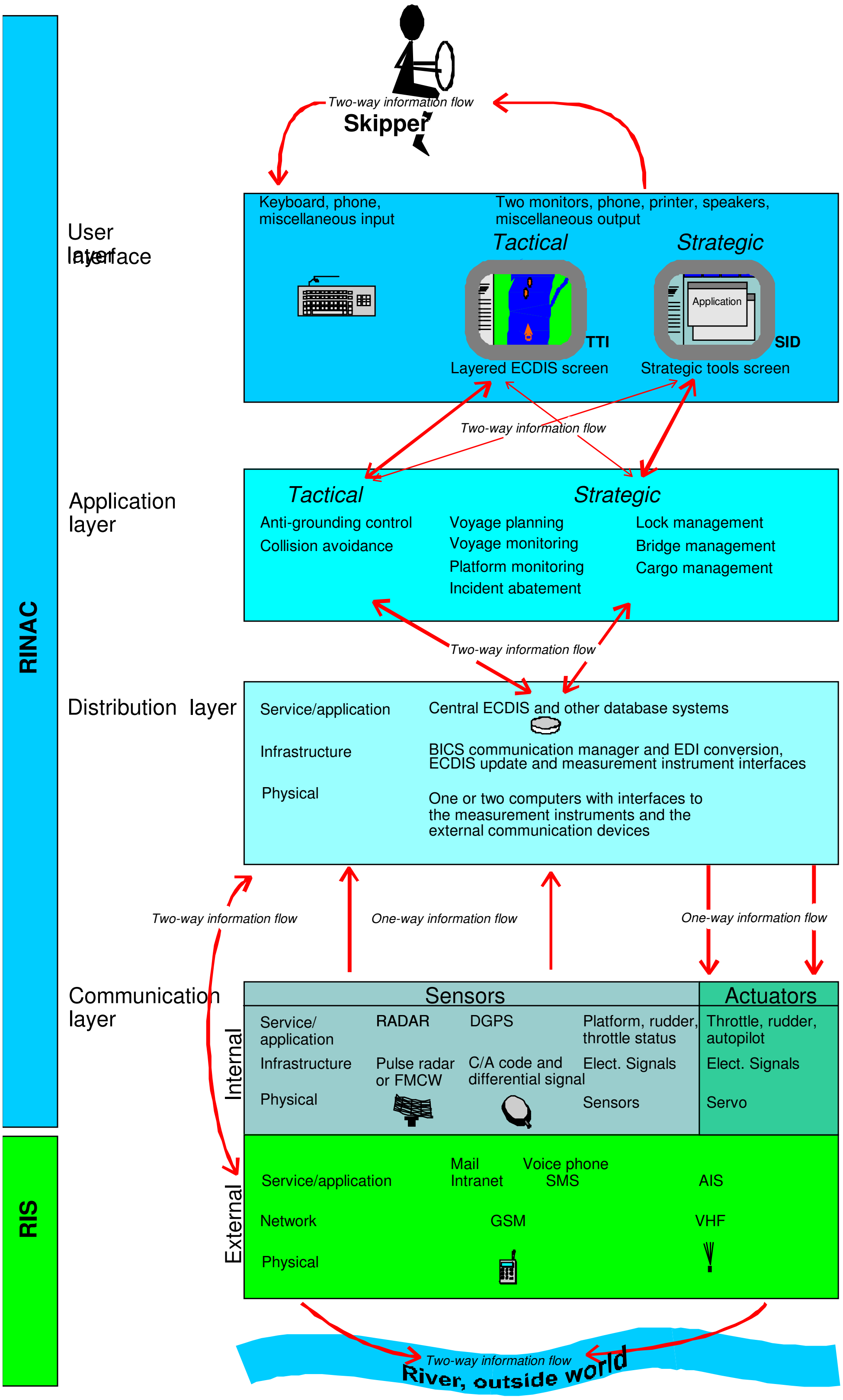

Figure 47: The RINAC architecture

5.3.2 Inland ECDIS display

The information density of the average Inland ECDIS ENC is much greater than that of a maritime ENC. At the same time concerns with regard to screen clutter are also much more relevant in inland navigation than at sea. Also for the reasons explained in § 5.2.1 user interaction required to retrieve information from the ECDIS application must be kept to a minimum. Manufacturers are trying to meet the demands from users and are coming up with innovative concepts, but as mentioned in § 1 already fundamental research in tasks and human behaviour on board of inland vessels and requirements with regard to the human machine interface that could provide guidance for the manufacturers, is failing. Clearly safety would be very much served by fundamental research on this subject.

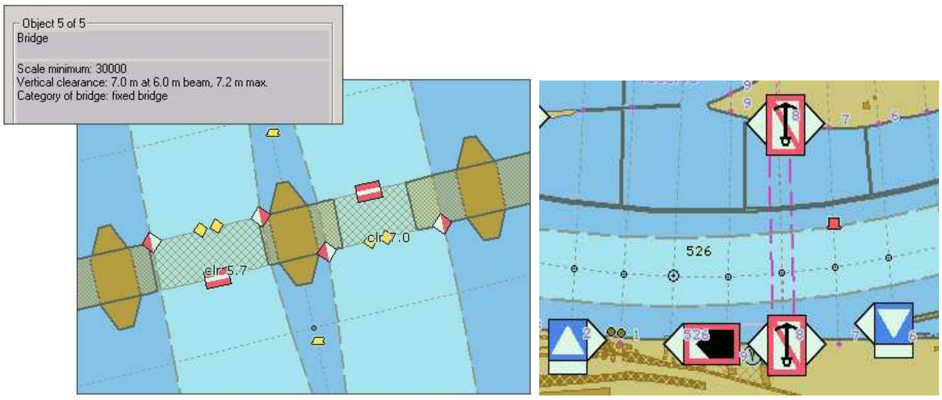

Figure 48 Inland ECDIS display enhancements

On the other hand given the wide scope of applications of Inland ECDIS, the reality of personal preferences and ongoing developments the Inland ECDIS expert group should continue to resist the continuing pressure to highly regulate the interface.

5.3.3 Tracking & tracing and the navigation display

Experience in the maritime world shows that on the one hand ARPA is a very valuable tool, but on the other hand has some major drawbacks in confined and crowded waters and in close quarter situations:

- ARPA symbols cause too much clutter on the radar display and may hide weak targets from small vessels.
- There is a discrepancy between the accuracy of the ARPA and the basic radar display.

The presentation of tracking & tracing/ AIS symbols on the inland navigation radar display will also have these drawbacks. The feedback from skippers participating in the INDRIS demonstrator in the Netherlands indicated a major concern with regard to screen clutter, even though the added information was appreciated.

Passing distances between vessels are significantly smaller in inland navigation than in sea-going navigation. The same applies to distances of shores. As a consequence inland vessels operate at much smaller radar ranges than seagoing vessels in open sea. Inland navigation radars operate at smaller wavelength than seagoing radars that in combination with the commonly used small ranges allow them to provide information on other vessels dimensions and heading. This is important information during passages of vessels. With regard to the Inland ECDIS display the amount of information is much more dense than on an ECDIS display in open sea.

Very lengthy and thorough research both in real life and in simulators would be needed in order to be able to draft man-machine interface (HMI) requirements that would apply to the entire range of situations that can be found in the outside world of inland navigation. Even then developments of soft- and hardware will continue as well as new demands from changing tasks will come forward; developments that will impose new challenges with regard to the HMI. Therefore apart from the HMI requirements that were already imposed by radar regulations it was decided to stay away from regulations with regard to the HMI other than some general suggestions.

When drafting the Inland ECDIS Standard it was recognised that there is too much variation in ship borne environments, tasks and users to make user interface requirements applicable in all situations. Nevertheless in inland navigation under bad visibility circumstances radar is (recognised as) the primary source of navigation (including traffic) information. Therefore the navigation mode requires that the added information from for example ECDIS shall not hamper the display of the radar return from other vessels. Until it can be assured that information from tracking & tracing including AIS when compared to radar information provides the same or better accuracy and reliability, this shall also apply to tracking & tracing information.

Sea ECDIS uses a triangle symbol to display AIS information of other vessels (see Figure 51). This triangle is oriented by the heading information and a vector to indicate the course of ground. These symbols assume availability of accurate heading information. However inland navigation vessels generally do not have accurate heading information available and ship's heading

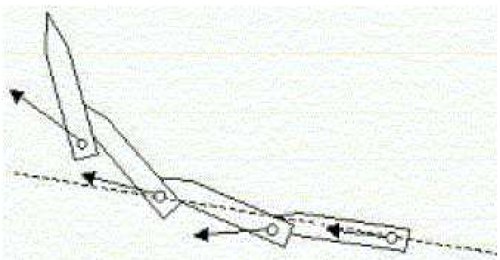

Figure 49 Heading vs course over ground

can deviate considerably from the course over the ground from the GPS.

Taking the previous into account a discussion between COMPRIS and the CCNR/ Danube Commission expert group on Tracking & Tracing [10] came to the following recommendations:

- Tracking & tracing (AIS) information is useful for the planning of the passing, but of no use during passing itself.
- Tracking & tracing (AIS) symbols should not disturb the radar image during passing and should be faded out therefore. Preferably the application should allow the skipper to define the area where such is the case.
- The sea ECDIS symbol should be used in inland navigation only when heading information is available.
- For vessels without heading information it is recommended to use a square.

Figure 50 Navigation desk mv Addio

Until it can be assured that information from tracking & tracing including AIS when compared to radar information provides the same or better accuracy and reliability and all vessels including small yachts etc are fitted with transponders, it would seem prudent to display tracking & tracing (AIS) information on a separate ECDIS display in information mode that is located near the radar display.

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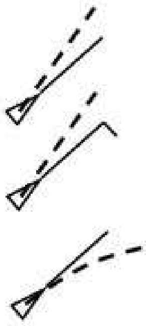
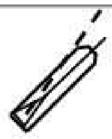
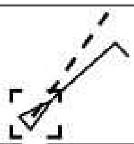
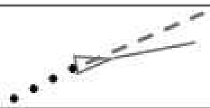
Table 3: AIS Target Symbols

Topic	Symbol	Description
AIS Target (sleeping)		An isosceles, acute-angled triangle should be used. The triangle should be oriented by heading, or COG if heading missing. The reported position should be located at centre and half the height of the triangle. The symbol of the sleeping target should be smaller than that of the activated target.
Activated AIS Target Including Dangerous Target		An isosceles, acute-angled triangle should be used. The triangle should be oriented by heading, or COG if heading missing. The reported position should be located at centre and half the height of the triangle. The COG/SOG vector should be displayed as a dashed line with short dashes with spaces approximately twice the line width. Optionally, time increments may be marked along the vector. The heading should be displayed as a solid line thinner than speed vector line style, length twice of the length of the triangle symbol. Origin of the heading line is the apex of the triangle. The turn should be indicated by a flag of fixed length added to the heading line. A path predictor may be provided as curved vector. For a **"Dangerous AIS Target"**, bold, red solid triangle with course and speed vector, flashing until acknowledged.
AIS Target – True Scale Outline		A true scale outline may be added to the triangle symbol. It should be: Located relative to reported position and according to reported position offsets, beam and length. Oriented along own ship's heading. Used on low ranges/large scales.
Selected target		A square indicated by its corners should be drawn around the target symbol.
Lost target		Triangle with bold solid cross. The triangle should be oriented per last known value. The cross should have a fixed orientation. The symbol should flash until acknowledged. The target should be displayed without vector, heading and rate of turn indication.
Target Past Positions		Dots, equally spaced by time.

I:\NAV\50\4.DOC

Figure 51 IMO AIS symbols

5.3.4 Azimuthing thrusters control

Azimuthing thrusters are becoming a standard for propulsion of tugs. On seagoing cruise vessels in recent years the so-called podded-propulsion became very popular[7]. Although not a mainstream development every now and then inland vessels are fitted with azimuthing thrusters for propulsion purposes. Examples are the Neokemp container vessels (see Figure 39). Generally when underway these vessels are steered by means of the earlier mentioned rate-of-turn pilot. For manoeuvring purposes the thrusters are normally controlled by a kind of a joystick that combines azimuthing and engine output control (see also Figure 13).

On tugs with azimuthing thrusters the skipper is located in between the control levers of the port and starboard thrusters (see Figure 52). With some exceptions (see Figure 20) on many inland vessels the location of the azimuthing control levers however is next to each other on the front desk (see Figure 53). Ergonomically this is an unfavourable position that both puts unnecessary strain on the muscles of the skipper, but also does make accurate manoeuvring a lot harder. Therefore it is recommended that designers of wheelhouses take a close look at the location of azimuthing thrusters' controls on tugs.

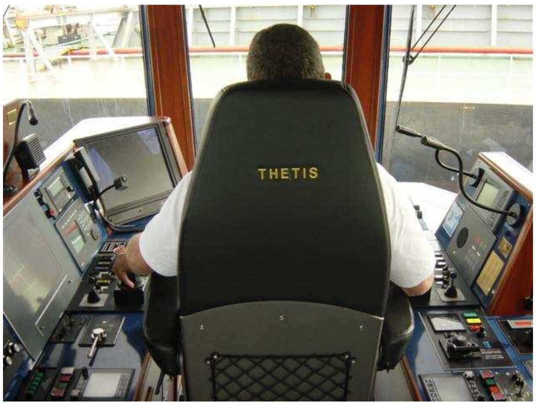


Figure 52 Thruster controls ASD tug Thetis

Figure 53 Standard thrusters control panel

5.3.5 Joystick control

Recently the first inland vessel was fitted with a so-called joystick control. Joystick control was first introduced for dynamic positioning purposes on offshore vessels. For many years now also seagoing cruise vessels are fitted with joystick control units. These appear to be very welcome for station keeping during tender operations. However, tests with even the latest version of joystick control as found on these vessels have shown that joystick control for normal manoeuvring, e.g. berthing:

[7] Recently podded-propulsion lost popularity considerably among cruise operators due to reliability problems.

- is less accurate than manual control by an experienced crew,
- reduces the weather window of vessels, and
- increases the power consumption.

The first reason mainly originates from inherent limitations in heading control: a commercial gyrocompass generally has an accuracy of about 0.7°. On a supplier of say 50 meters length such accuracy generally is acceptable. However on a seagoing cruise vessel of 300 meters 0.7° translates in an inaccuracy of about 3.5 meters. When berthing captains tend to find this relevant. The reason for the latter two findings is the fact that the control routines have to apply to a wide variety of situations and weather conditions and thus are a compromise, which usually hardly includes optimisation (i.e. minimising) of the propulsion output.

Figure 54 Kongsberg joystick interface

An additional effect of joystick controls on cruise vessels appears to be that in many cases the crew looses their skills to manually manoeuvre the vessel in emergency situations.

With regard to the human machine interface the joystick seems a step forward compared to the conventional number of controls of an inland vessel, i.e. rudder tiller(s), engine control(s) and bow thrusters control. For a sidestepping[8] manoeuvre this clearly holds true. Most of the manoeuvres of inland vessels are not sidestepping however, but involve moving ahead or astern and turning with either bow or stern close to other objects. It is in this respect where joysticks do not meet human machine interface requirements. Conventional controls allow the skipper to 'play' with the mass of the vessel to influence the drift behaviour. Conventional controls allow the skipper to immediately address the bow or the stern to be too close to the jetty or to another vessel by using just the bow thrusters control lever respectively the rudder tiller. The present joystick applications on the other hand require the skipper to manipulate the pivot point, the heading and the side thrust component to have the same effect. It also requires considerable experience with the vessel and the particular joystick.

Figure 55 Lipsstick

Given the increasing rotation of personnel there seems room for improvement of the manoeuvring interface of vessels. However a thorough study of the range of manoeuvres that should be addressed as well as the hydrodynamic aspects is needed before one can define an improved manoeuvring interface. Such new manoeuvring interface should be utmost reliable and be able to cope with all manoeuvring situations with sufficient performance.

[8] Moving sideways on a parallel heading.

6. CONCLUSIONS

- Inland navigation knows a considerable number of highly detailed technical regulations. However fundamental research in tasks and human behaviour on board of inland vessels and requirements with regard to the human machine interface that could provide support for such regulations and guidance for manufacturers, is failing.
- The process of shifting away from paper forms, notices to skipper, chart, etc puts much more emphasis on the use of PC's on board. With regard to the human interface it will however be a major challenge to compensate for the fact that even on a modern inland navigation vessel work is not the average office job and that even a modern inland vessel's wheelhouse is not the average office environment
- The expansion of the sailing area of inland navigation will make it impossible to keep up local knowledge throughout this area and calls for other solutions like detailed electronic charts and voyage planning software applications. On the other hand there seems no need for an imposed switch to the English language in inland navigation. Autonomous developments in the European society with regard to language are likely to address this issue. In the mean time translation aids and translated software will bridge the gaps.
- Digital (2-wire, bus) systems are increasingly taking over both observation and control of operational systems on board of inland vessel new-buildings. This seems to call for regulations especially with regard to operating systems. However any requirement to refrain from the use of main-stream operating systems to enhance reliability and thus safety would result in developers moving out of the market and thus a very likely total stall of development.
- The failing of official ENCs of the larger part of the European waterway network is seriously hampering the introduction of RIS applications.
- The rate-of-turn autopilot is one of the major improvements with regard to workload in inland navigation. On the other hand the proposed track-pilot for inland navigation and joystick pilot control seem to be mostly technology driven developments. Especially the track-pilot seems to be taking automation one-step to far: Safety requires the skipper/ helmsman to stay actively involved in the navigation process. On the other hand there seems room for improvement of the manoeuvring control interface.

- Where nowadays many road transport companies use tracking and tracing both for internal purposes and as a service to their clients it seems likely that some form of tracking and tracing will find its way into the wheelhouse of inland vessels. On the other hand one would expect the privacy and commercial interest of inland navigation getting similar protection to the privacy of any European citizen and the commercial interests of any other European company. Also inland waterway transport being the preferred transport mode for highly sensitive cargos like ammonia and LPG seems in conflict with tracking and tracing information being publically broadcasted and available to anyone at any time.

7. RECOMMENDATIONS

- There is a strong need for fundamental research in tasks and human behaviour on board of inland vessels and requirements with regard to the human machine interface that could provide support and guidance for policy makers and manufacturers.
- Given the wide scope of applications of Inland ECDIS, the reality of personal preferences and ongoing developments the Inland ECDIS expert group should continue to resist the continuing pressure to highly regulate the interface.
- Rotation of personnel there is need for standardisation of the human machine interface.
- The location and design of wheelhouses needs further attention.

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PHOTOS/ PICTURES