Statistical method for determination of safe pilot system interface

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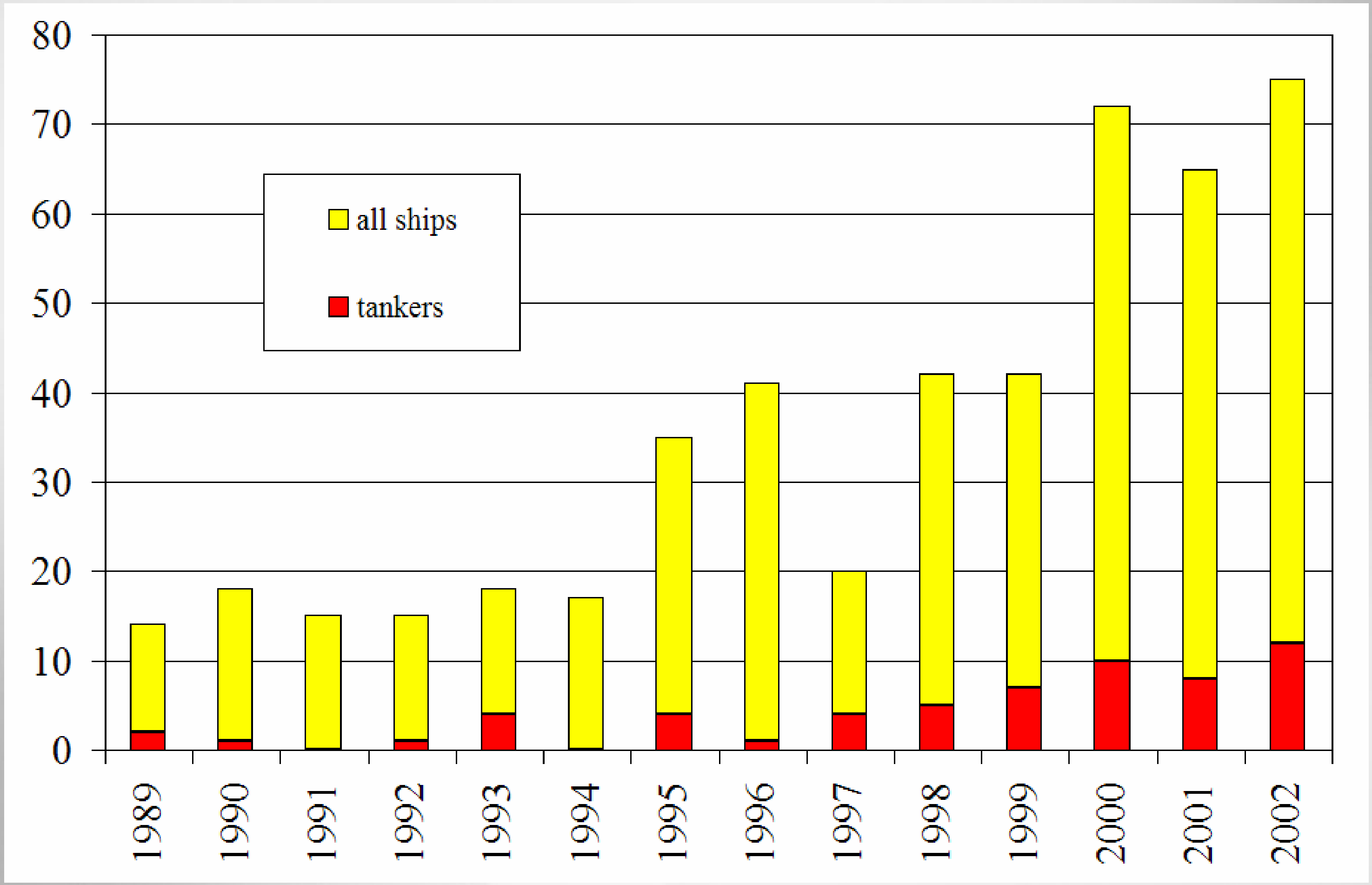
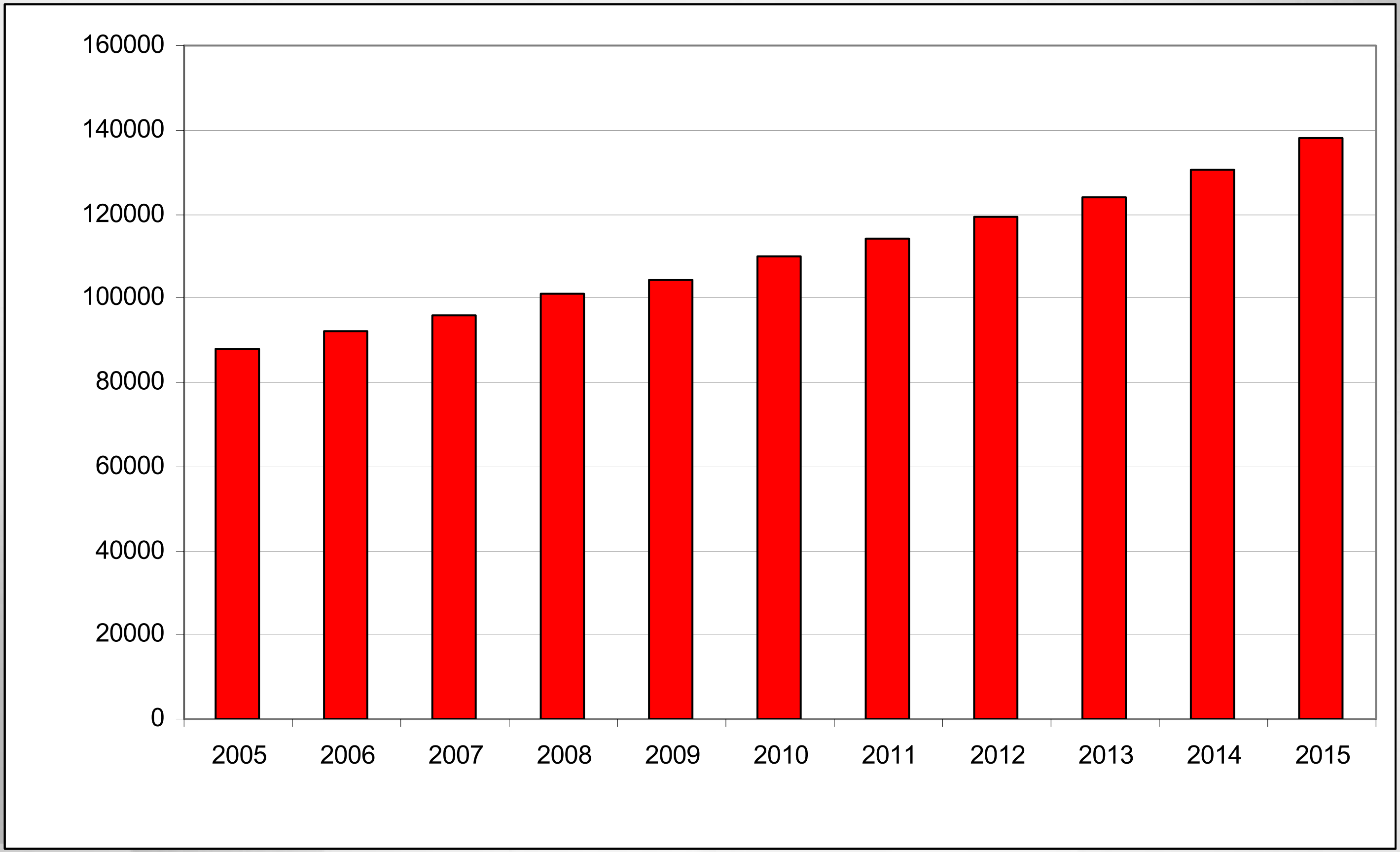
Introduction



Number of accidents at area of Baltic Sea

Introduction



Traffic forecast at area of *Kattegat* (entrance to Baltic Sea)

Pilot navigation ???

In the process of navigating in restricted waters, because of the fast changes in the vessel's position in relation to objects ashore.

The vessel's position is determined in the mind of the pilot.

In the process of conducting pilot navigation the pilot can be supported by the PNS (Pilot Navigation System).

Navigational safety criteria

Pilot navigation consists in performing three following tasks :

- Planning a safe manoeuvre.
- Determining the location of the vessel in a given area with definite accuracy.
- Controlling the vessel's movement providing for safe performance of the planned manoeuvre.

The general condition of navigational safety in these areas:

$$\left.\begin{array}{r} \mathbf{d}_{\mathbf{ijk}}(1-\alpha) \subset \mathbf{D}(t) \\ p(x, y) \in \mathbf{D} \quad h(x,y,t) \geq T(x,y,t) + \Delta(x,y,t) \end{array}\right\}$$

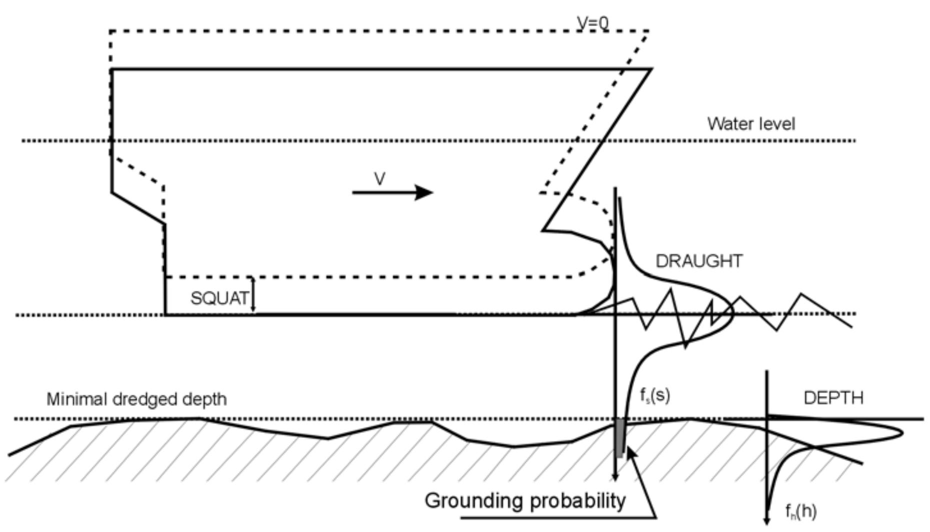
where:

$\mathbf{D}(t)$	–	available navigational area (fulfilling the condition of available depth at moment t),
$\mathbf{d}_{ijk}(1-\alpha)$	–	safe manoeuvring area (traffic lane) of the of the i-th vessel performing the j-th manoeuvre in k-th navigational conditions determined on confidence level $1-\alpha$,
$h(x, y, t)$	–	depth of the area at the point with coordinates (x, y) at moment t,
$T(x, y, t)$	–	vessel's draft at area point with coordinates (x, y) at moment t,
$\Delta(x, y, t)$	–	underkeel clearance at area point with coordinates (x, y) at moment t.

Practically =

- ►establishing the vessel's safe speed,
- ►establishing safe underkeel clearance,
- ►planning the tactic of particular maneuvers in the restricted area.

Definitions of parameters



$$P_A = P_{SA} \int_{h_{\min}}^{+\infty} f_s(s)ds$$

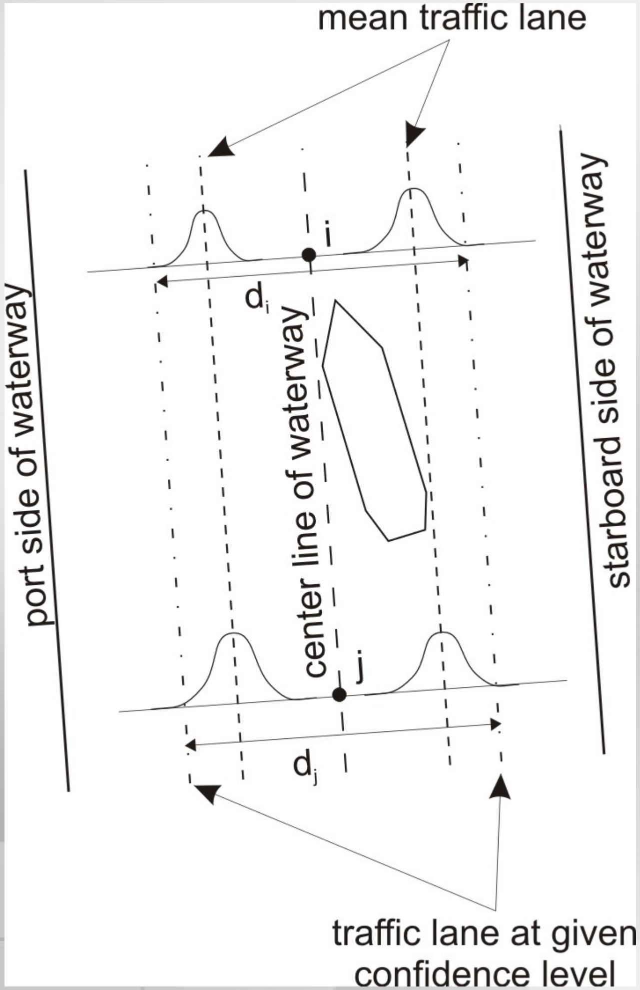
where:

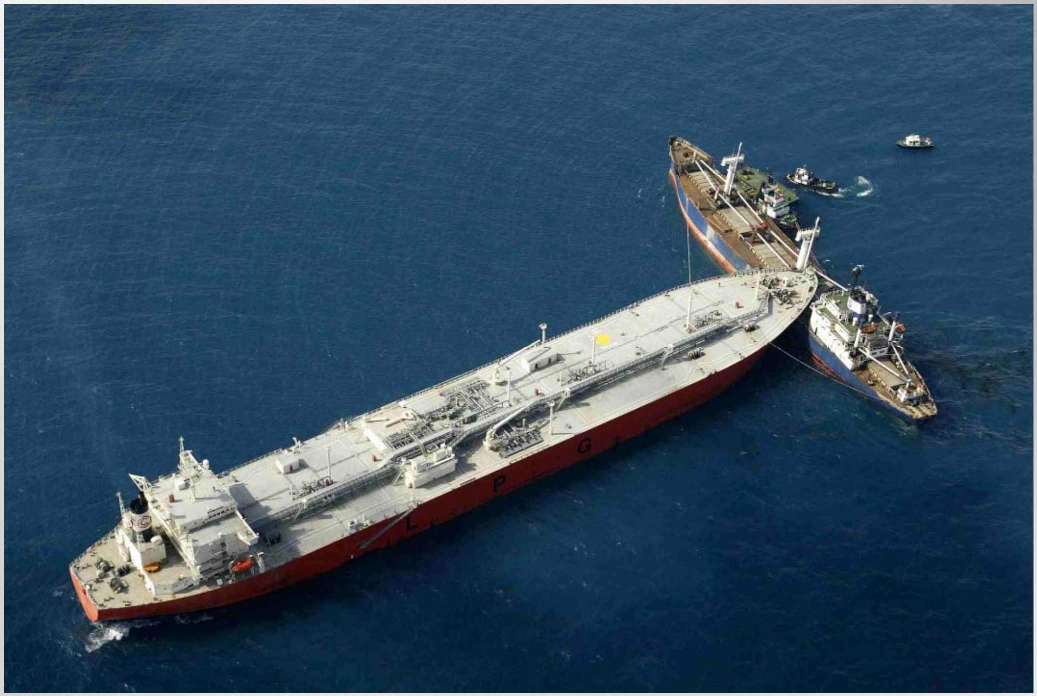
A-accident

$f_s(s)$-extreme ships keel points horizontal distribution

SA-serious accident

Definitions of parameters





Risk level

Pilot Navigation System ensure

- Precise positioning
- Reliable information
- Optimal visualization

application

Usage of PNS affects risk level

Scope

The basic errors of the PNSs currently produced are :

- the information presented is not the optimal information which causes it not to be taken advantage of in the utmost degree and there are difficulties with its being absorbed by the pilot;
- lack of special images useful in pilotage navigation, like: in relation to the shore, in relation to the fairway axis;
- lack of optimal user interface;
- lack of a maneuver prediction system.

These errors result from the fact that systems being only modernizations of the systems functioning in unrestricted water areas (ECS or ECDIS), for the needs of pilotage, and were not optimized for pilot navigation.

A team of researchers from the Navigational Department of the Maritime University of Szczecin, within the framework of a project co-financed by the Ministry of Education and Science, undertook to work out the optimal solution for a pilotage navigational system, making use of scientific methods of constructing navigational systems. As a result of research carried out, two PNS prototypes were developed:

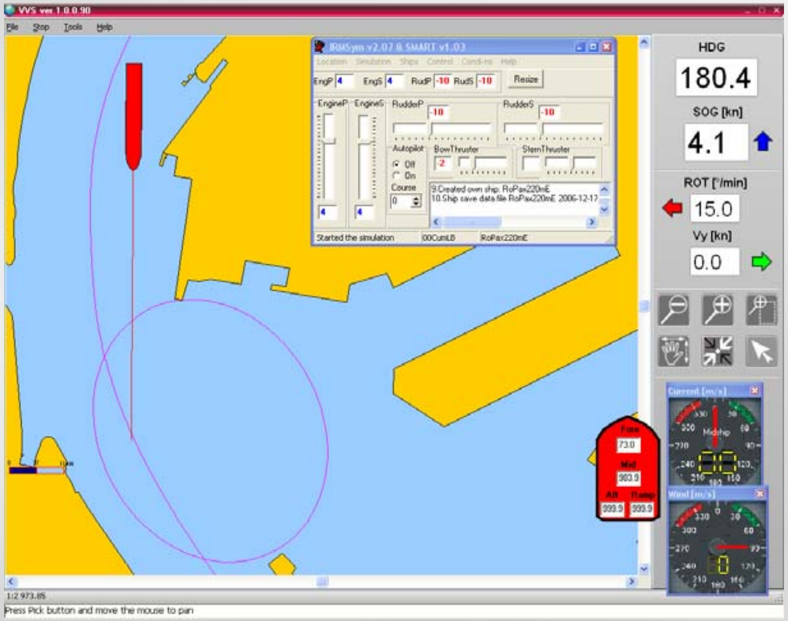
- a stationary one, designed for sea ferries,
- a portable one, designed for pilot use.

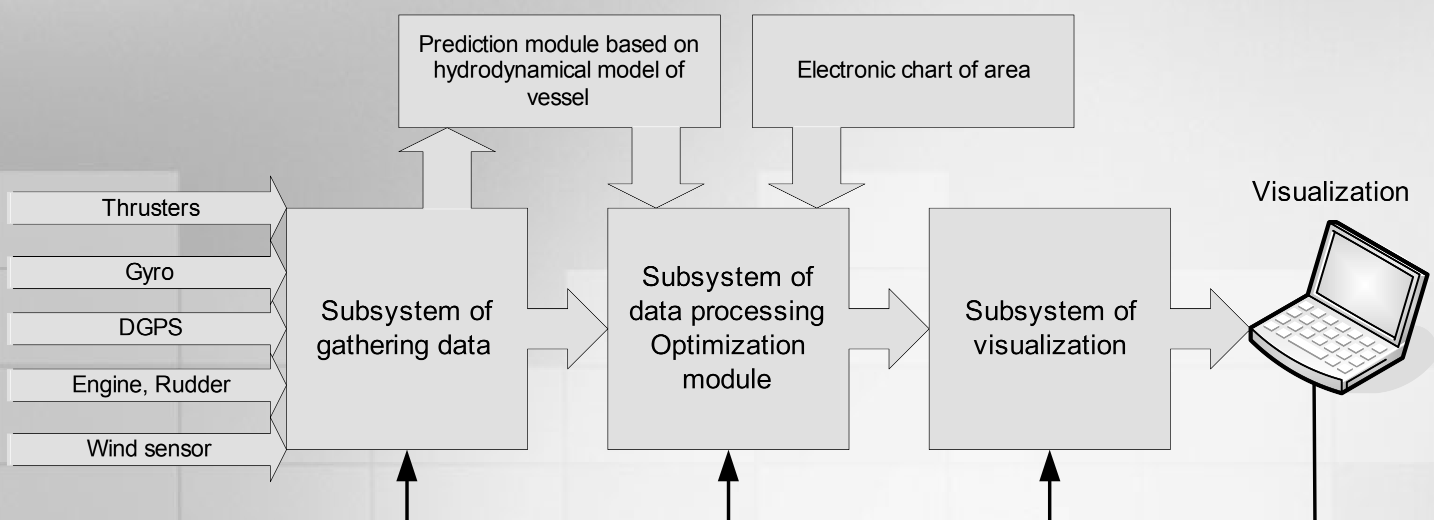
At present these prototypes are undergoing experimental research and are being prepared for starting production. The following elements make up these systems:

- subsystem of electronic charts,
- positioning subsystem,
- information processing and imaging subsystem.

Optimization method

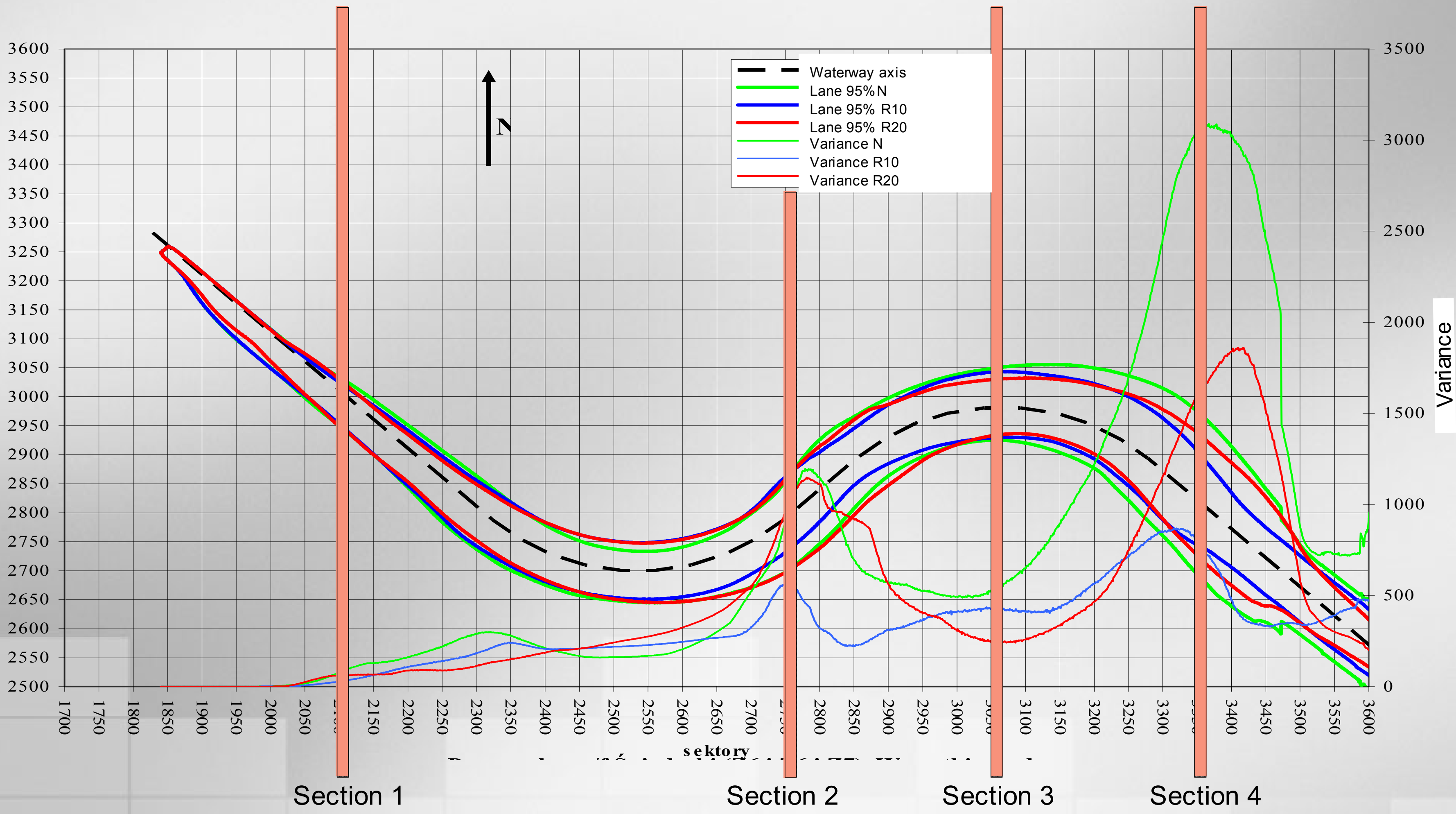
Simulated runs
Experts (19 captains)
3 scenarios (criteria – orientation)





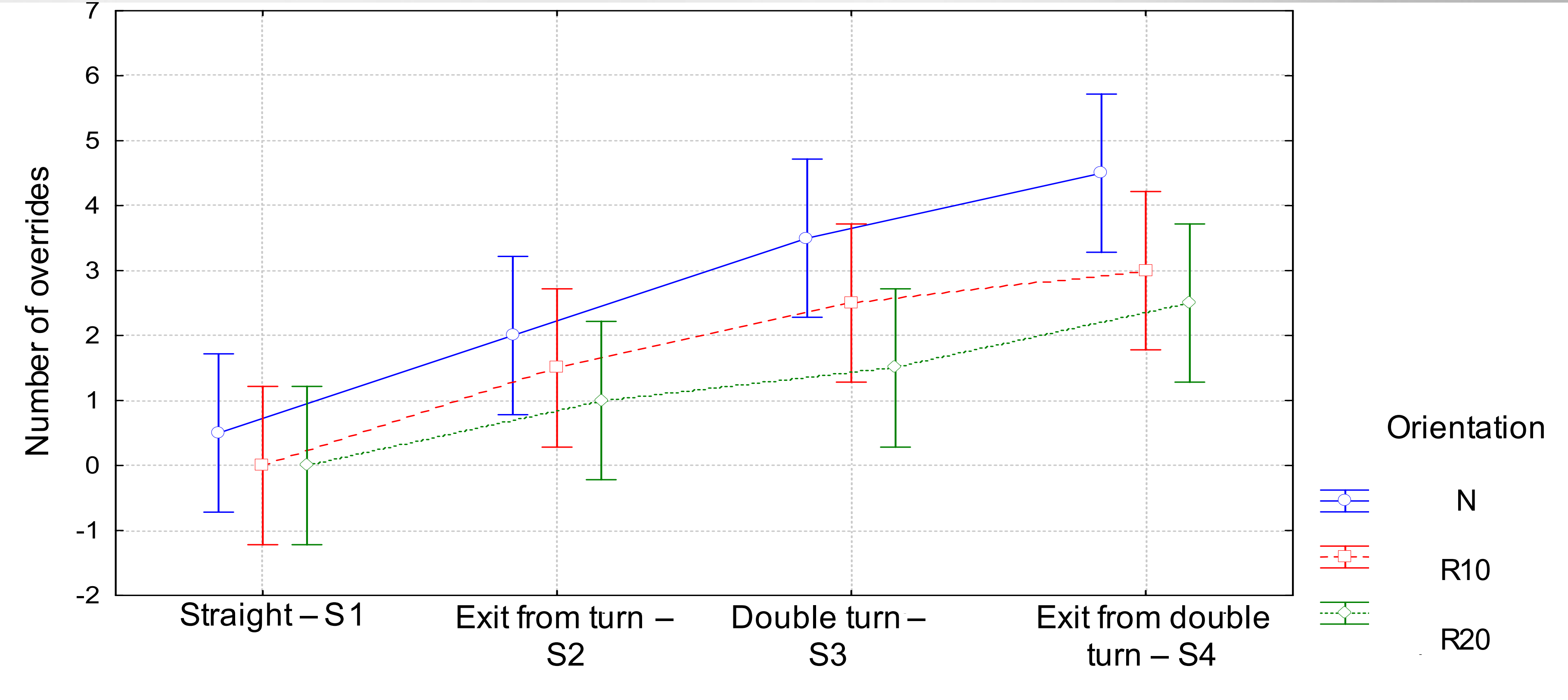
Experiment overwiev

Manova anlisys of traffic lanes for different orientation



Outcome

Manova results comparison



Conclusions

In article model of information optimization for Pilot Navigation System is presented. Details of MANOVA analysis for maximum traffic lanes leads to following conclusions:

- highest values of waterway width are at area of exit from double turn(section 4),
- waterway width is larger for third and fourth analyzed section (entrance and exit from double turn),
- analyzing number of waterway overrides, most efficient orientation is waterway axis (R) orientation, with 20 deg change of waterway (R20).
- Additional researches, regarding variants R10 and R20 shall be considered.

Thank You For Attention