ANM16/9/4

TO: - ANM Committee (16th session)

Cc: - Custodians of document 1058 Ed1 (Formally ANM15-12-5)

- Pernilla Bergstedt

- Hendrik Eusterbarkey

THE NETHERLANDS

CONTRIBUTION, COMMENTS AND PROPOSALS

FOR SUBSTANTIAL MODIFICATIONS AND ADDITIONS TO DOCUMENT ANM15-12-5

1058 Ed1

the Use of Simulation as a Tool for Waterway Design and AtoN Planning_Dec2007

by

- ERNST BOLT	MINISTRY OF TRANSPORT, PUBLIC WORKS AND WATERMANAGEMENT DEVELOPMENTTEAM NATIONAL NAUTICAL TRAFFIC MODEL (NVM)
- RAYMOND SEIGNETTE	PORT OF ROTTERDAM
- JAN RICKEN	NETHERLANDS COASTGUARD

Section	Where	Proposed action	Specification
1	Whole section	Needs further clarification and/or discussion	Section 1 says: *“Simulation tools are capable of providing realistic and accurate results and input to the investigation and evaluation of channel and port design. The purpose of simulation for AtoN design, planning and evaluation is to identify and mitigate the risks for the mariner operating in a specific waterway, channel and port area. It also includes evaluation of channel layout, placement and technical specification of AtoN and manoeuvring aspects."* With this text it is suggested that the outcome/results of the simulations will provide a good prediction of the expected practice. However, appearances are deceptive as each model is only a restriction of reality. To our opinion it will be an improvement to the text to *“recommend simulation tools as aids to enhance the process of weighing the various alternatives (e.g. designs or safety measures)”.* The relative differences of simulation results are valuable; however the absolute results are just a restricted approach of what may be expected.
4.1	After 1st 2 bulleted items	Delete	;
5	Whole section	New text	See attachment I
6	List of cap	Add	▪ calculation of hydrodynamic interaction forces and moments between vessels ▪ need to simulate manoeuvring behaviour of tugs, and which way the tugs need to be controlled
7	After paragraph “The geographical database…”	Insert	The environmental conditions (waves, current, wind) are usually defined location dependent. Separate models may be needed to prepare these conditions before commencing the simulations.
Annex A 1.1	After 3rd paragraph	insert	The tool is also useful in selecting suitable scenarios for a full-mission simulator research. The tool provides information about physical feasibility of a scenario, i.e. whether it is possible to steer the vessel along a desired track within the physical limits.

Annex A 1.1	4th paragraph	Replace by	The tool can be applied in a deterministic manner: the helmsman is replaced by an autopilot which reacts with a determined response to deviations from the track. As this autopilot is fed with perfect knowledge of the state of the vessel and the environmental influences, it is not certain that a human operator will be able to produce the same results. The subsequent full-mission simulator research fills this in. Another way to apply the tool is in a probabilistic mode. In this setup the uncertain knowledge of the helmsman and variations in his behaviour are represented by stochastic functions. By repeating the simulation many times with new stochastic deviations (a so-called Monte Carlo process), an impression of the variations in tracks is obtained. Of course, the width of this swept path is very much dependent on the choice of the stochastic parameters.
Annex A 1.1	1st Disadvantage	Delete "not real time"	This is an advantage because calculations can be much faster. If, for some reason, it is important to run real time it is easy to force the model do so.
Annex A 1.1	2nd Disadvantage	Consider further specification, what was meant here?	I imagine this applies to all models? The stochastic parameters mimicking the human in the loop are disputable, however. Perhaps it is advisable to use the stochastic variations only for environmental conditions, so that it is clear that the simulation represents the ideal autopilot only.
A – 2. 2	Figure 1	Add title	single display system with outside view and external handle box
A – 2. 2	Figure 2	Add title	Multi-display system
A – 2. 2	3rd par. last sentence and 4th par	Replace by	As the simulations normally involve a single person, communication with other ships, port and VTS facilities is not simulated. Other traffic may be in the simulation but will just follow pre-programmed tracks.
A – 2. 2	Advantages	add	▪ visualisation can make issues clear also for non-mariners

A – 2. 2	disadvantages	add	▪ the required input preparation, especially for 3D mode, approaches that of a Full-Mission simulation ▪ it may be questioned whether the advantages justify the extra costs compared to fast-time simulation
A – 3. 3	5th advantage	Consider clarification or deletion	Not clear what is meant by this.
A – 3. 3	Advantages	add	▪ may be made movable (e.g., built into a standard container)
A – 3. 3	Last disadvantage	Add fundament (or leave out)	What cues then? What differences are there with the Full Mission simulator? The outside viewing angle is usually larger for the F.M., but if needed an extra monitor may be added to provide the relevant sector. The image quality itself is usually better than a projected FM image.
A – 4.	Figure 7 top right	Replace picture	(is also tug bridge picture)
A – 4.	Disadvantages	Add	• qualified mariners and/or local pilots (in two shifts) needed during entire simulation period • for statistical reliability, many mariners/pilots should each perform a number of simulations • the (unwanted) training effect of simulating the same scenario a number of times is unknown ▪ the effect of the relatively short simulation, allowing for a sustained high attention level, is unknown
A - 5	Entire section	replace	See following text.

5. Traffic models

A number of model have been developed to assess the nautical safety of a shipping area, either or not in comparison to a reference situation. Usually the safety is expressed as the expected number of accidents of a specific type per year in the area concerned (as this should be a very small number the reciprocal value is often presented: e.g. one accident in 15 years). The models may be classified as follows:

Geometrical models

In this type of model, traffic flows are assigned to tracks with a certain lateral distribution. The transits of individual ships are not simulated, but instead the geometrical probability that ships come close to each other forms the basis for the probability of an accident. As the ships are not simulated there is no way a ship can react on the vicinity of another in order to avoid a contact.

The translation from geometrical probability to the probability of an accident can be based directly on accident statistics, by calculating the geometrical probability for a reference area of which a sufficiently long record of accident data is available. The assumption is then that the observed ratio of accident probability to geometrical probability can be used as a scaling factor to calculate the accident probability from the geometrical probability in the new situation.

Different refinements may be applied to get a closer relationship between the number of accidents and a calculated exposure. The exposure is again based on the geometrical probability, but more details of the possible causes of an accident are included.

To clarify this, two ways to model the contact of a ship with a fixed object are described here.

- The intended track of the ship traffic is represented by a line or line segments. To describe the fact that the individual ships do not stay exactly on this line, a lateral distribution of the traffic has to be specified. This could be a normal distribution centred on the intended track, or a distribution derived from AIS tracks in an existing situation. The portion of the lateral distribution that runs over the obstacle is used as the exposure. It is clear that this exposure is very dependent on the choice of the intended track and the variance of the lateral distribution.

- Just as before an intended track is assumed. If a ship is to hit the obstacle, she has to leave this track somewhere and keep this wrong course long enough to reach the obstacle. Thus, for each infinitesimal part of the track the probability that the object would be hit may be expressed as a function of the necessary course shift and the distance to the object. By integrating this figure over the entire track an exposure can be calculated.

The first method is purely geometrical whereas the latter uses an analysis of the possible development of an accident.

The geometrical models may generally also be classified as macroscopic (based on traffic flows, not on individual ships) and static (no means of reacting on situations as they develop during the simulation).

Maritime Traffic Simulation models

This type of models involves the simulation of individual ships. Each ship gets its own manoeuvring characteristics, intended track, etc. and tries to follow this track during the simulation as an autonomous agent. When a traffic situation develops where ships would approach each other too close, this should be detected and the responsible ‘agent’ should alter his speed and/or course. This behaviour may based on relatively simple rules, to comply with the collision regulations and other (local) constraints, but also a more sophisticated model representing the behaviour of a ‘human operator’ may be used. Although such a model may eventually produce a traffic behaviour that very much seems to resemble what is seen in practice, the question remains how one should judge on the safety (expressed as an expected number of accidents per year) of the simulated scenario. Even if a (near) accident would occur in the simulation, it is more likely than not that this is due to a shortcoming in the modelling of the agent.

In some cases this problem is solved by, again, using accident statistics. If the simulation model is used to reduce complicated traffic situations to a combination of elementary situations, there may be enough accident data to determine a reliable accident rate for each elementary situation. Some models attempt to model the human operator in such detail that fault mechanisms, which eventually may lead to an accident, can be described. The necessary parameters for this model may (partly) be based on studies on the behaviour and functioning of human operators in other fields, such as process industry, aviation or military operations.

These models may also be classified as microscopic (describing the manoeuvring of individual ships) and dynamic (during the simulation, the ships react on traffic situations that occur).

Which traffic model?

Each model has its specific strengths and weaknesses. No model exists that is capable to answer all questions in this field; which model is preferred and what level of detail is required depends on what problems have to be addressed and what data are available. AIS data is an increasingly important source to analyse and to calibrate models of the behaviour of vessels and ship traffic, but AIS data do not reveal everything and do not provide predictions.

Developments are still ongoing, and possibly the strongest points of different models will be combined.