Abstract
This paper presents the work of the EPDIS-project, which is carried out by a consortium of six partners from different European countries and co-funded by the 5th Framework Programme of the European Commission. The project-idea is to introduce 3D-visualisation to the maritime community and connect it with the information of the Pilot Book. The 3D-Models and the Pilot Book databases have been built for two demonstration areas and will be installed on board of two ships in order to be tested by the crews. EPDIS will be able to be used in two different modes: in "Drive"-mode it will be connected with the ships-data and display the view as seen from the bridge. In "Explorer"-mode it will be possible to investigate 3D-models on its own path.

Introduction
This paper will introduce to you the work done in the Project "Electronic Pilot Display and Information System (EPDIS)". EPDIS is a European Research and Development project conducted under the 5th Framework Programme and co-funded by the European Commission, DG Information Society (IST-2001-35306). The project started in April 2002 and will last until the end of March 2005.

The Consortium consists of six partners from four different countries. They are:

1. SAM Electronics GmbH:
   SAM is one of the world's leading marine suppliers of equipment, systems and installations for communication, navigation, hydrography as well as automation, power and propulsion technology. They are situated in Hamburg, Germany. They are the co-ordinator of the project.

2. CETEMAR, S.L.:
   CETEMAR undertakes specialist maritime consulting for public maritime authorities and private industries and collaborates in R&D projects relating e.g. to the development of complex systems and the application of advanced technologies. CETEMAR is based in Barcelona, Spain.

3. ISSUS:
   ISSUS is the former R&D department of the Hamburg Marine Academy. Until 1st April this year, the Institute of Ship Operation, Sea Transport and Simulation (ISSUS) was a unit of the Hamburg University of Applied Sciences and was then transferred to the
University of Science and Technology Hamburg-Harburg (TUHH), at the same time widening its scope of work to maritime logistics, thus bridging the gap between technology and waterborne transport of passengers and goods.

4. Estonian Maritime Academy (EMA):

EMA, based in Tallinn, Estonia, has more than seven hundred students studying every year in four main study areas. It also has approximately four hundred marine engineers every year participating in additional vocational training courses.

5. FRESTI:

FRESTI is a Portuguese company from Lisbon. The main activities of FRESTI are those related to advanced maritime technology applications, consulting and education & training of personnel engaged in the fishing and maritime field, both ashore and at sea.

6. SACOR Maritima, S.A.:

The company specialises in the maritime transportation of petroleum products, operating mostly along the Portuguese coast, and in the transportation of petroleum products to the Azores and Madeira. It also operates in the international market with 12 different vessel types. They are situated in Lisbon, Portugal.

The work presented here stems from the whole consortium and is the result of the collaboration of all project partners.

Support of Navigation

Size and draught of container vessels are increasing rapidly and an end to this development cannot currently be foreseen. Ports and waterways are approaching their limits and beyond. For both port operators and ship owners, reliability in terms of time and performance is of utmost importance and therefore precise navigation is becoming an issue of vital interest. For large ships in narrow waterways, shipborne equipment according to international carriage requirements is often not sufficient to ensure the required accuracy of navigation and also depends on the navigator’s understanding of the manoeuvring situation.

Because of all this, the navigator of the future will have to bear much higher responsibility than today. Therefore it is necessary to develop strategies to meet the increasing demand in an efficient and safe manner and to assist the responsible officer on the bridge in coping with the rising demands. Navigation must be adapted alongside ship development. We have to assist the mariners in dealing with the higher demands and develop technologies which can support them in an efficient way.

Nowadays the most efficient way to train navigators and prepare them for their next passages is to practise in a simulator. Fully equipped modern simulators can emulate the whole environment including wind, current, sea condition, the behaviour of the ship, etc. Due to the 3D models used the training is most realistic. It is possible to use them to practise any passage under real conditions and find out how the ship has to be sailed in different conditions.

But simulator time is very costly and time consuming. The trainee has to go to the simulator and stay there for several days, which often includes travel expenses and hotel
costs. On the other hand, technology is continuously enhancing and it is foreseeable that in some years regular off-the-shelf computers will be able to host simulator programmes, which nowadays still need highly sophisticated machines. Thus far no application exists that implements the simulator technology on board. We think that it is necessary to bring 3D-models aboard to begin with and integrate them into the workflow and this is what EPDIS aims to achieve.

**Project Idea**

The initial project idea of EPDIS derives from the Pilot Book, a book describing coastlines, harbours and their approaches. Pilot books often depict shorelines and navigational landmarks by sketches or photographs to provide a more detailed understanding to the mariner than only words could do. Current on-board technology, from GPS to ECDIS, has made position finding easy and has reduced the significance of pilot books. Seafarers, however, are not sufficiently aware of the fact that an accurate position on a chart does not necessarily match reality because of deficiencies in the sea charts. In some geographical areas shorelines and shallows are charted quite inaccurately. Hence the navigators most important tool, his eyes, have not lost their importance at all and viewing through the bridge windows in addition to reading displays is still a crucial part of prudent seamanship. To master challenging manoeuvring situations, a navigator must quickly and realiably compose a true picture of the real situation from all available sources.

But there is still lots of useful information in the book like radio signal information, phone and fax numbers, addresses, pilotage, etc. EPDIS tries to find a way to conserve the information of the Pilot Book by developing an up-to-date framework for it and making it electronically available. This information will be combined with a simple 3D-landscape-viewing tool in which one can see the relevant area and explore it. The navigator shall also be able to take a look at the objects from which he got some information in the Pilot Book. One can say that this viewer would replace the drawings of the original Pilot Book.

By providing him with this technology, the navigator could construct a much better and more realistic mental navigation model than he has been able to do so far. At present he builds up his model from the chart and the radar, having no idea what the landscape really looks like. With EPDIS he can experience a challenging passage or a port approach either prior to the real navigation or he can use the tool as a support during the conning process.

**The implementation**

Basically EPDIS consists of three elements: the databases, the Viewer and the Electronic Pilot Book (Fig. 1). The databases can be separated into two. The first contains the 3D-models including the terrain and objects such as lighthouses and other prominent buildings. These models can be regarded by the Viewer. The second database contains the Pilot Book Information which will be read by the Electronic Pilot Book. The EPDIS application itself combines the Viewer and the Electronic Pilot Book and connects them to the ECDIS. From there it will get the ship information necessary for a proper display, e.g. height of the bridge, position, course, heading.
The 3D-models have been created in Open Flight Format (flt). Open Flight is more or less the standard format for simulation and thus was our preferred choice. To create the 3D-Models we first built the landscape models by connecting Digital Elevation Models with S-57-ECDIS-data. This "backbone" of the 3D-model was improved by building 3D-objects of principal marks and other conspicuous objects and integrating them into the 3D-model. The viewer (Fig. 2) is based upon Open Scene Graph. Open Scene Graph is a free and open source library that can display flt-files. It is a software kernel that improves the graphics library of the computer system. It is independent of a system software and can be modified by C++ programming.

The Pilot Book Information has been stored in an SQL-database. The data can be retrieved via a user interface and will be displayed with XML, thus enabling them to be viewed in many applications, e.g. a browser (Fig. 3).

EPDIS will be used in two different modes. Due to the connection with the ECDIS it will be possible to connect the 3D-view with the position, the heading and the speed of the ship. Thus the view as seen from bridge will be displayed in this mode. This could be of use during the conning process. In the other mode it will be possible to explore the 3D-terrain on its own path, e.g. prior to a challenging passage.
Figure 2: Screenshot of the EPDIS-Viewer

Figure 3: Screenshot of the Electronic Pilot Book
User involvement

As EPDIS is creating a new technology, which is not used so far on board, it is very important to include the potential users from the beginning. Therefore we carried out several user workshops where we tried to investigate the expectations of the user community. These opinions were incorporated into the specification of EPDIS. In the last phase of the project, we plan to install the equipment on board two ships and let the users work with it in order to get detailed feedback of how the equipment works and how it can be used in the future. Both demonstrators will be equipped with the 3D-models and the electronic versions of the sailed areas and thus the crews will be able to be assisted by EPDIS.

We will install EPDIS on a fast ferry in service between Tallinn and Helsinki. This ship travels several times a day between the two cities. The approach to Helsinki is supposed to be particularly demanding and we are looking forward to seeing how the crew will like the tool. The second demonstrator will be installed on a tanker in service along the Portuguese coast.

Conclusion

Simulators are the most effective tools for training seafarers, but are at present only available in premises ashore. Integrating simulators into the on board equipment would facilitate optimum preparation including actual wind, current and traffic features or could support the conduct of a passage.

Developing this tools will be a challenging task, i.e. concerning the presentation of the information. We will have to ensure that the information is organised into task- and operator-related areas in order not to overload the navigators mentally.

EPDIS will not be the first on-board-simulator, but it will be the first step in their development and it will deliver the most important feature for such technology: the 3D-viewer. But even more important for the project will be first impressions from people working on board with a 3D-tool, their experiences and their opinions on how the tools should be enhanced.

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