Abstract

The use of and the business around inland waterway navigation in Flanders are often assumed to be non-sustainable and outdated. However, after taking a more profound look, this assumption appears to be not correct. Therefore, and in order to promote inland waterway navigation, the student-competition named ‘Ecorace-Challenge’, is presented in this paper. The aim of this competition is to stimulate entrepreneurship among students, and to make them aware of the opportunities inland waterway navigation offers future careers. As such, comparable with other student-competitions, like e.g. Formula Student, a competition for universities and colleges in close collaboration with industry and educational institutions was devised with the aim to improve the interaction between young people and this interesting sector. Within the competition, each student team will have to find business partners and sponsors to build their own vessel with a sustainable drive train. In addition, they need to make a business plan and present it to a jury of professionals. As such, the student teams will act as real ship builders, trying to sell their ideas to investors.

Keywords: Ecorace-Challenge, Inland Waterway Navigation, Engineering Education, Sustainability

1 Introduction

The inland waterway network in Flanders is one of the most dense networks in the world. Rivers and canals extend for 1375 km, of which 1076 km are used for professional navigation. According to recent studies, there is a considerable reserve capacity on the waterways, which is not the case for road and railway transport. Despite the opportunities waterway transport offers, it still struggles with some contemporary issues to obtain a modal shift. It has a dated infrastructure, polluting vessels, as well as an outdated image. Improvements in terms of environmental friendliness and sustainability are essential for inland waterway transport, especially concerning the emissions of particulate matter and nitric oxide. Nevertheless, Flanders takes actions to stimulate and encourage people and industry to reinvent the waterways in a sustainable way and tries to demonstrate its environmentally friendly aspects in
the logistics and transportation sector. This is done by launching several initiatives where organizations work together on different aspects of inland navigation. An example of these initiatives is ‘Water-Truck’, where the aim is to further develop and optimize cargo transport using small inland waterways by introducing a new navigational concept, consisting of a pusher and adapted pushed barges. Also in the field of education, Flanders is stimulating awareness about inland waterways. GROUP T – International University College Leuven and Waterwegen en Zeekanaal NV, one of the two administrators of the Flemish waterways, have developed a boat competition for technical students focusing on inland waterways. In the ‘Ecorace-Challenge’ teams of technical students from different universities are being challenged to build a 6 meter long vessel, which represents a scale model of a typical inland waterway vessel. The primary focus is on developing an alternative drivetrain which propels the vessel more efficient and sustainable than current practices. During the design phase, they need to take into account strict regulations which are imposed by the organization of the competition.

An important objective of the ‘Ecorace-Challenge’ is to bring students and maritime industry closer together. Therefore, during the year prior to the race, the teams are invited to attend several seminars where they will be introduced to the sector and its companies. Within these seminars students will gain insight in how navigable waterways can be complementary to road or railway transport in order to obtain multi-modal transport. At the end of each of these seminars, students and professionals can interact during a networking event. What is more, the ‘Ecorace-Challenge’ also wants to encourage entrepreneurship and innovation within this sector. Therefore, the teams need to write a business plan to elaborate on the possible scalability of their project to the industry. Herein, the knowledge and expertise gained during the seminars and meetings with professionals can be used.

During the weekend of the race the self-designed vessels will be inspected to check compliance with the regulations. In parallel, the sustainable and innovative aspects of each design are inspected and assessed based on level of difficulty, progression and innovation. Because the technical regulations of the competition allow a wide variety of energy sources, vessels using hydrogen (fuel cell or combustion), bio-fuels or solar energy can be expected. Next, during the navigation challenges in different disciplines, several aspects of the vessel will be investigated and scored, like speed, manoeuvring with a load of 1 ton and passing through a lock.

The goal of this challenging project is to make people (especially students) aware of the opportunities and importance of this transport mode and to show the inland waterway sector for the future. Based on the potential of the competition, it can be concluded that the Ecorace-Challenge, a boat race for technical students in terms of sustainability and environmental friendliness, is a good project to make (young) people aware of the transport mode of the future: inland waterway transport.

2 Inland waterway navigation an interesting and sustainable industry

Inland waterway still play an important role in nowadays transportation, especially in western Europe where a dense network of waterways can be found. The Belgian waterway network is regionalized and is hereby divided into the following categories: the Flemish Region, the Walloon Region, the Brussels Capital Region and the maritime accesses. In the Flemish Region, the waterway network is managed by two waterway managers: “Waterwegen en Zeekanaal NV” and “NV De scheepvaart.” “Waterwegen en Zeekanaal NV” manages the central and western part of the Flemish waterway network. “NV De Scheepvaart” manages the most important waterways in the province of Antwerp and Limburg. The Belgian waterway network is an important passage to waterways in other West-European countries like The Netherlands, Germany, France, Luxembourg and Austria. Besides, the port of Antwerp is the second largest port of Europe and has an interesting strategic location, right in the middle of crossroads of major European trade routes.

This dense network results in a lot of possibilities for the versatile use of the waterways within different transport modes. Flanders has several channels that reach deep into the inland. It is therefore logical that the combination of water and road transport has strong assets. Sea and inland waterway transport in combination with modal shift will be the transport mode of the future and will play an important role in reducing the pressure on the roads in the future.

Water transportation is one of the oldest means of transport. In consideration of Europe and Belgium there is ample availability of water so transportation can be done throughout the year. As water transport is done by river, canals, inland and sea which are the natural ways, cost efficient, safe and environmental friendly, it can be seen that this transport mode has a
lot of potential compared to other modes of transportation. Compared to road, air and rail transport the use of ships is very sustainable and environmentally friendly. The energy consumed to cover a certain distance is much more efficient. For example, a ship of 1350 tons consumes four to seven times less fuel per kilometre than trucks. Moreover, with 5 litres of fuel a ship can transport a ton of goods for 500 km, whereas a train a train can only travel 333 km, a truck only 100 km and an airplane hardly 6.6 km. This benefit includes also less polluting emissions into the air. A long-term trend is the decline in the number of inland ships, accompanied by an increase in the load capacity which make the waterways even more attractive.

### 2.1 Challenges for Flanders inland waterways

Improvement in terms of environmental friendliness and sustainability can still be made for inland waterway transport, especially the emissions of particular matter and nitric oxide. The lifetime of a cargo ship can easily reach over 20 years. In many cases the type of drive train has been kept original, but technologies has improved and nowadays available technologies are more efficient and cleaner. The EU already announced some measures and regulations to reduce the emissions of nitric oxide by 2020. Therefor R&D and innovation in the inland waterways sector has to be encouraged.

Moreover, as a result of the outdated image and infrastructure of this business, people don’t see the opportunities and benefits. It’s not only an interesting, economic and environmental way of transport but it can also be an interesting alternative to release the pressure on our highways when we manage to combine water, rail and road transport. Therefore people need to be made aware of the need of sustainability and environmental friendliness in the logistics and transport sector.

### 3 The Ecorace-Challenge

To encourage young people to interact with the businesses around inland waterway transport, Waterwegen en Zeekanaal NV and Group T – International University College Leuven launched a new competition for bachelor and master students. The aim of the “Ecorace-Challenge” is to strengthen the interaction between Education, Research and Industry and to stimulate the business climate within the sector, so new developments and initiatives can be launched.

The teams are challenged to start their own small organization as ship builders. They will have to design and build a small scaled-down eco-friendly driven vessel based on the plans of an original ship that is being used for inland navigation today. For the realization of their vessel the teams needs to gain their own financial and material recourses.

During the period of one year before the race, teams need to periodically brief the organization about their progression. They also need to take into account deadlines which they need to take care of. For example, at certain moments during the competition, documents need to be handed in like design reports, a FMEA study and a business plan.

During this year teams will also be invited to different networking events by companies and organisations within the sector. Consequentially students can hopefully benefit from their new contacts and insights in the sector. Occasionally they will be asked on events to talk about their experience with the Ecorace-Challenge and what their progression is. At the end of competition they will have to present the business plan to a jury of professionals active in the inland waterway sector and/or research institutes. It is of big importance that teams use the information and the insights of the network events for their defence.

### 3.1 Teams

It is the first time this competition will be held. Therefore the organizing committee opted to only allow a small amount of teams to participate within the pilot edition of the race. Because the competition is funded through Flanders industry, only Flemish Universities were able to apply to the event. The competition of May 2014, will host four universities which will compete against each other: University of Antwer, Hasselt University, KU Leuven and Antwerp Maritime Academy. The event will take place at the marina nearby the lovely city of Ieper.

![Map of Belgium showing the participating Universities](image)

Figure 1: Map of Belgium showing the participating Universities

### 3.2 Technical Regulations

Within the technical side of the competition, each team will build a vessel capable of sailing more than
30 km. They start from line diagrams of a barge which is scaled down to a boat with a length of 6 m. The teams are free to produce their own hull in any material. They can opt for standard glass-fibre composite solutions or look for more sustainable options like for example bio-composites. Before the teams are allowed to sail the vessel during the competition all team needs to indicate by calculation that the hull is strong enough. This matter is very important when you know there will be always one or two person on board with the possibility of an additional load of one ton. Additionally, the vessel will be inspected in detail during the official scrutineering.

To inform all teams of the different technical restrictions a document of about 20 pages was written. The main purpose of this document is to assure that all vessels comply with a high standard of safety. Besides, it also allows a fair competition between the teams.

The designs rules for the propulsion system are relatively open. The regulations allow different types of fuels, going from solar panels, hydrogen, CNG, petrol to bio-fuels. Only wind, human and animal power are not allowed. This can be used for direct propulsion or for on-board energy generation which may be stored in an energy storage system of maximum 5 kWh.

Teams are only allowed to make some design changes within the last meter of the 6 meter long hull to optimize their propulsion system. The standard hull speed is determined at about 12 km/h, but can still be improved. The maximum allowed output power for the propulsion system is 8 kW or 6 hp. The topology of propellers is open, so one or more propellers are allowed to improve manoeuvrability. Teams need to take into account the scalability of their drive train, so it is more or less possible to apply the same system in an up-scaled barge. This will be of importance for the decisiveness of their business plan.

3.3 Overall regulations

The competition doesn’t consist of only one race. Multiple challenges are defined to make sure the boats can be used in versatile situations, so it is agile, sustainable, fast and reliable. Additional to the challenge a more management-oriented part is introduced where teams show how their organization as ship builders works. Each challenge and assignment will be score separately with points. At the end the team with the highest overall score will be awarded as the winner of the “Ecorace-Challenge”. The scoring of the different challenges and assignments can be found in table 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Max. points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design report</td>
<td>100</td>
</tr>
<tr>
<td>FMEA</td>
<td>50</td>
</tr>
<tr>
<td>Electrical scheme report</td>
<td>100</td>
</tr>
<tr>
<td>Sprint</td>
<td>50</td>
</tr>
<tr>
<td>Forward-stop-backward</td>
<td>50</td>
</tr>
<tr>
<td>Slalom</td>
<td>50</td>
</tr>
<tr>
<td>Endurance</td>
<td>300</td>
</tr>
<tr>
<td>Business plan and presentation</td>
<td>100</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>800</strong></td>
</tr>
</tbody>
</table>

3.4 Challenges

The competition exist out of four different practical tests on the water: Sprint, Forward-Stop-Backward, Slalom and Endurance. Whereby each team tries to set a best time for each challenge. The winning team gains the maximum point of the challenge where the points of the other team are calculated by an formula taking into account the time difference with the fastest team.

3.4.1 Sprint

Within this challenge, teams need to cover a distance of 200 meters as quick as possible, starting from standstill. Teams may change propellers if needed. The goal is to accelerate as quick as possible

**Figuur 2: Illustration of the Sprint Challenge**

3.4.2 Forward-stop-backward

Having a good manoeuvrable ship for inland waterway navigation is essential. During the challenge the shipper is challenged to sail 100 meters where after he needs to come to a standstill in a marked area. Next, he will need to navigate 100 meters backward. This challenge will be scored on time, but as well by a jury on its smoothness.

**Figure 3: Illustration of the Forward-stop-backward Challenge**
3.4.3  Slalom
For the slalom the vessel needs to follow a track indicated by buoys of 250 meters. This test will show how stable and agile the ship is. This challenge will be scored similar to the Forward-stop-backward.

![Illustration of the Slalom Challenge](image)

Figure 4: Illustration of the Slalom Challenge

3.4.4  Endurance
The flagship of all the challenges is the Endurance: a 26 km long trajectory on the Ieperlee canal in Flanders. During this part of the race teams will pass a lock on their way four times. The first half of the trajectory, teams will sail without any ballast. The second half, teams need to take an extra ballast of a ton on board of the vessel, as shown in figure below.

![Illustration of the Endurance Challenge](image)

Figure 5: Illustration of the Endurance Challenge

In contrast to the other challenges, not only time will be taken into account but also efficiency. Each vessel power consumption will be monitored. A formula taking both parameters into account will determine the points gained during this challenge.

![Relation efficiency vs Speed](image)

Figure 6: Relation efficiency vs Speed

3.5  Award ceremony
At the end of the competition three different prices are awarded: the overall winner of the Ecorace-Challenge, which is the team with the highest total score, the most efficient vessel, to the team that completed the Endurance challenge in quick but most efficient way and the most innovative vessel, to the team that most excels in the use of new technologies.

4  Conclusion/Summary
As result of the dense network of rivers and canals in Flanders, inland waterway transport still has a lot of potential to grow. Unfortunately, throughout the years the image of the sector has become outdated and less attractive. Now it is the time to reinvent the business and to show the public the potential and its benefits. Waterway transportation can be seen as an economical and sustainable alternative to road and rail transport.

Therefore this paper presented an interesting initiative “Ecorace-Challenge” to reduce the gap between Education, Research and the Inland Waterway Navigation, especially by young people. The initiative is a competition for bachelor and master students with a certain interest in maritime industry. The Ecorace-Challenge covers both a technical side, where each team needs to build a 6 m long vessel, and a more management-oriented side, where the team needs to act as real ship builders and present their business plan to a jury of experts. For the proper conduct of the competitions guidelines and regulations were defined which each team needs to comply with.

In May 2014 all teams will come together in Ieper where the challenges of the first Ecorace-Challenge will take place. This public event shall be organised in collaboration with lots of support of the maritime sectors and related companies and organisations.

Acknowledgement
We would like to thank all the partners involved with the “W&Z Ecorace-Challenge”, for their participation and collaboration during the competition. We also would like to thank “Waterwegen en Zeekanaal NV” for their partnership and for their trust in Group T International University College to set up the competition.

References
Authors

Prof. dr. ir. Geert Waeyenbergh has Masters degrees in Bio-engineering and Industrial Management and a PhD degree in Mechanical Engineering from K.U. Leuven. Currently he is Assistant Professor at GROUP T and associated researcher at K.U. Leuven – Mechanical Engineering Department. His lecturing courses are related to marketing management, operations management and transportation and mobility management. He currently is the coordinator of GROUP T’s Intelligent Mobility projects and is member of the research group ‘sustainable engineering’. His main research interests include sustainable logistics, transportation and mobility, maintenance and reliability.