



# UPM 2011 INTERNATIONAL ACADEMIC COMPETITION ON UNDERWATER GLIDERS DESIGN

## RULES OF THE COMPETITION

## 1. Global description

Ocean gliders are small underwater unmanned vehicles with very low energy consumption. They are able to cover great distances using only the energy of small and light batteries.

Most underwater vehicles, like submarines, use a spinning propeller to move around in the water. Propeller driven vehicles are fast, but they also require a lot of energy to maintain their speed. Underwater gliders move around by changing their buoyancy, that is they change their density such that they alternate between more dense and less dense than the surrounding ocean water. This change in buoyancy causes the glider to rise and sink in the ocean.

As the underwater glider goes up and down, its wings give it a forward motion just like the wings on an airplane glider, which is why these devices are also called gliders. But airplane gliders can only "glide" as they fall downwards due to gravity. Underwater gliders can glide forward both as they rise and fall.

In a typical configuration, the ocean glider changes its density by moving a small piston forward and back that increases and decreases its volume. You may remember that you can calculate the density of an object by taking its mass and dividing that by the object's volume. Since the mass of the glider remains constant, all we need to do is change its volume. A small change in volume (about a half cup of water) is all the glider needs to change its density enough to rise and sink in the ocean. Other ideas and configurations will be welcome in this competition.

The objectives of this international academic competition are:

- Promote the development of the underwater gliders.
- Involve the university students in the underwater gliders design.
- Optimize the underwater gliders designs.
- Obtain new ideas for the future application of the underwater gliders in the scientific and business environments.





This competition has an international scope and its main goal is the design of a small underwater glider concept radio controlled, according with the technical requirements of these rules, taking into account the future application of the underwater gliders in the scientific and business environments.

## 2. <u>Requirements for the participants</u>

Teams of all the universities worldwide are allowed to participate in the competition.

Each team should not exceed the number of 4 members.

All the participants must prove that they are currently students in a university, by means of a certificate. A copy of the certificate must be sent by e-mail during the registration phase.

## 3. <u>Competition phases</u>

The phases of the competition will be:

#### Phase 1: Registration.

The teams should register sending an e-mail with the subject "UPM 2011 INTERNATIONAL ACADEMIC COMPETITION ON UNDERWATER GLIDERS DESIGN" to the address <u>ocean\_gliders.navales@upm.es</u>, including the following table with the team information:

Team name		
Country		
Coordinator	Name	
	University	
	Postal address	
	E-mail	
2 <sup>nd</sup> member	Name	
	University	
	Postal address	
	E-mail	
3 <sup>rd</sup> member	Name	
	University	
	Postal address	
	E-mail	
4 <sup>th</sup> member	Name	
	University	
	Postal address	
	E-mail	





Copies of the certificates proving that all the members of the team are currently students in a university must be attached to the registration e-mail.

The company Dessault Systèmes, which sponsors the competition, will provide educational licences of its PLM systems to be used in the competition. The maximum number of licences provided to each team will be equal to the number of members of the team. The licences will expire at the end of the phase 3 of the competition. For the 5 finalist teams the licences will be prorogued to the end of the competition.

## Phase 2: Project submission.

Each team should submit a report, redacted in English, in PDF format, clearly specifying:

- State of the art of the underwater gliders.
- Global scope of the proposed design.
- Application of the proposed design in a scientific or business environment, specifying the special characteristics of the design for this purpose.
- The dimensions and detailed drawings of the proposed design.
- The materials and construction techniques that will be used for the manufacture.
- Displacement, weights and stability calculations.
- The theoretical calculations or experimental data on which the proper operation of the proposed design is based.
- Study of the dynamic conditions of the designed underwater glider.
- Control conditions during sink and rise maneuvers.
- Estimated vertical and horizontal velocities.
- Costs analysis.
- References.

A file with the 3D model of the proposed design must be submitted, accomplishing the following requisites:

- 3D model file formats: 3dm, kmz, iges, stl, obj, vrlm, ply, off.
- Textures: If used, submit them in a zipped file.

The designs will be published in Internet as part of the initiative "Proyecto 3D-Seed". With their participation in the competition and the submission of the 3D files, the teams give their tacit consent to the usage of the files in this initiative. The designs can be slightly modified to optimize Internet downloading. An example of the usage of the files in Internet can be shown in the web page http://tour-etsin.blogspot.com/search/label/3D-Seed.

Resources for sending big size files will be available.





## Phase 3: Finalists' proclamation.

The maximum number of finalist teams is restricted to 5.

The Technical Committee will select the best 5 projects based on the following criteria:

- The quality of the submitted report.
- The quality of the submitted 3D model.
- The originality and viability of the application of the proposed design in a scientific or business environment.
- The quality of the theoretical calculations or experimental data used for the design of the underwater glider.
- The adaptation to the technical requirements of the competition.

#### Phase 4: Construction.

During the construction phase each of the 5 finalist teams must construct their underwater glider following the specifications of the report submitted in the project submission phase.

The finalist teams will make modifications to their designs in the construction phase, if they do not change the global idea of the design, improve it and are accepted by the Technical Committee.

#### Phase 5: Underwater gliders delivery.

During the delivery phase each of the 5 finalist teams must deliver the underwater glider to the following address:

Canal de Ensayos Hidrodinámicos Escuela Técnica Superior de Ingenieros Navales. Avda. Arco de la Victoria s/n 28040 Madrid (SPAIN)

#### Phase 6: Preliminary trials.

Each finalist team will have a maximum of 1 hour to do the preliminary trials in and the final adjustments in the towing tank before the competition.

#### Phase 7: Competition.

The competition will be a public act that will be celebrated in the *Canal de Ensayos Hidrodinámicos* of the *Escuela Técnica Superior de Ingenieros Navales* (ETSIN) of the *Universidad Politécnica de Madrid* (UPM).





Each finalist team will have two opportunities to test the underwater glider under the following conditions:

- 1. In the starting moment, when the chronometer will be started, the underwater glider must be afloat and stopped on the water surface.
- 2. The underwater glider must sink continuously to a depth of at least 1 m and must rise continuously to a floating position, similar to the starting position.
- 3. The process in the former point 2 must be repeated at least one more time.
- 4. The chronometer will be stopped the first time the bow of the underwater glider rises though the water surface after cover a distance of at least 10 m from the starting point.

There will be an underwater video signal to check the depth of the underwater gliders during the competition.

The best time obtained during the two opportunities will be taken into account for each team.

The Technical Committee will draw lots to decide the participation order

If necessary, and to improve the tests, the Technical Committee can change the competition conditions, on equal terms for all the teams.

#### Phase 8: Awards proclamation and ceremony.

The Technical Committee will generate an act with the results of the competition.

The decisions of the Technical Committee will be unappealable.

The award ceremony will be a public act.

#### 4. <u>Calendar</u>

Phase 1: Registration	Deadline	15 Jun 2011
Phase 2: Project submission	Deadline	02 Sep 2011
Phase 3: Finalists' proclamation		23 Sep 2011
Phase 4: Construction	Deadline	14 Dec 2011
Phase 5: Underwater gliders delivery		14 Dec 2011
Phase 6: Preliminary trials		14 Dec 2011
Phase 7: Competition		15 Dec 2011
Phase 8: Awards proclamation and ceremony		16 Dec 2011







#### 5. <u>Technical requirements</u>

The maximum overall length of the underwater glider will be 2 m.

The underwater glider design must allow dismantling it and mounting it again easily. The weight and size of the dismantled underwater glider must be adequate to transport as baggage in a plane, train or bus. This will guarantee that the teams will carry the underwater glider as part of their baggage without extras costs.

The underwater glider will be tested in the Canal de Ensayos Hidrodinámicos of the ETSIN of the UPM, which has 100 m length, 3.8 m width and 2.2 m depth.

The trials will be in calm water.

The underwater glider must support the hydrostatic pressure without deformation.

The movement of the underwater glider will have 6 degrees of freedom, controlled by a radio control system, but their movements will be limited as follows:

- Vertically the underwater glider will not contact the bottom of the toeing tank.
- The operative width of the towing tank, where the underwater glider must be during all the tests, will be 2.5 m, distributed as presented in the figure 1.



Figure 1: Towing tank transverse section

The Organizer Committee will provide radio control equipments to the 5 finalist teams, with a limited budget of 250.00 Euros for each team. To avoid excessive costs the radio control system will communicate with the underwater gliders by means of a buoy in the water surface.

The detailed specifications of the radio control elements will be communicated to the teams after the registration phase.

The total cost of the underwater glider (excluding the radio control system) will be lower than 300.00 Euros.





## 6. Financing

There is a maximum budged of 300.00 Euros for the construction of the underwater glider of each finalist team.

Only the payments previously accepted by the Organizer Committee will be paid.

For all the cases it will be necessary to present the invoices with the VAT number given by the organizers, redacted in English or Spanish.

#### 7. Organizer Committee

Main Investigator	Luis Pérez-Rojas [UPM]
Coordinator	Jesús Valle [UPM]
Members	Eloy Carrillo [UPM]
	Miguel Ángel Herreros [UPM]
	Ernö Peter [UPM]
	José Andrés Somolinos [UPM]

#### 8. Technical Committee

The members of the Technical Committee, that will evaluate the projects, will be:

President	Luis Pérez-Rojas [UPM]
Secretary	Jesús Valle [UPM]
Members	Alberto Álvarez [NURC]
	Enrique Álvarez [Puertos del Estado]
	Eloy Carrillo [UPM]
	Eduardo Cuadrado [Dassault Systèmes]
	Scott Glenn [Rutgers University]
	Josh Kohut [Rutgers University]
	Carlos Ruiz de León [Innovamar]
	José Andrés Somolinos [UPM]
	Joaquín Tintoré [IMEDEA (CSIC-UIB) ICTS SOCIB]
	Guillermo Vizoso [IMEDEA (CSIC-UIB)]

#### 9. Technical help

The company Dessault Systèmes, which sponsors the competition, will provide educational licences of its PLM systems to be used in the competition. The maximum number of licences provided to each team will be equal to the number of members of the team. The licences will expire at the end of the phase 3 of the competition. For the 5 finalist teams the licences will be prorogued to the end of the competition.





## 10. <u>Prizes</u>

There will be 4 categories of prizes:

## 1. Prizes UPM for the design optimization

Only the 5 finalist teams will compete for these prizes.

1<sup>st</sup> prize: 1,200.00 Euros 2<sup>nd</sup> prize: 900.00 Euros

## 2. Prizes Dassault Systèmes

All the awarded teams will be also awarded with educational licenses and online courses of the designing tools of the company Dassault Systèmes.

The company Dassault Systèmes will award the Spanish team that better applied the PLM solutions with a visit to their facilities in France.

3. Prize UPM to the best idea for the application of the proposed design in a scientific or business environment

All the designs presented to the competition will compete for this prize.

Prize: 1,000.00 Euros

## 4. Prize SOCIB for the best technological innovation

All the European designs presented to the competition will compete for this prize.

SOCIB will award the best technological innovation presented by a European team with a subsidy up to 2,000.00 Euros to cover the travel expenses to participate in a ICTS SOCIB glider mission, in Mallorca during 3 days and 2 nights. The awarded team will visit the laboratories of IMEDEA/TMOOS in Esporles and ICTS SOCIB in Parc Bit, where they will learn from engineers and investigators of SOCIB and IMEDEA about tank equilibration, mission configuration, transmissions and communications. At the end of the visit the underwater glider will be launched in open sea.

All the participants will receive a certificate of participation.

The total amount of the prizes must be shared between the members of the team but UPM will not distribute it, giving the total amount to the coordinator of the team.





The legal taxes will be deducted for the prizes in all cases.

The Technical Committee can declare void the prizes if the requirements of the competition are not achieved.

The students of UPM can ask for free configuration credits for their participation in this competition.

#### 11. Disqualification

The Organizer Committee will take the appropriate measures and/or disqualify, with no previous warning, all participants breaking the rules.

#### 12. Intellectual property

The intellectual property of any work presented in this competition will be shared between the team and the organizers that will use them for educational and raising awareness purposes.

With their participation in the competition and the submission of the 3D files, the teams give their tacit consent to the usage of the files in the initiative "Proyecto 3D-Seed".

#### 13. Legal aspects

The Organizer Committee, reserves the right to establish new rules, change or modify existing ones, if the circumstances so recommend. In that case they will notify all the participants, who will have the right to present their statements.

With their inscription in the competition the participants accept the above set of rules.

The teams must present accreditation of their universities guaranteeing the coverage of their civil responsibility during the competition.

The participant teams accept, with their participation, the decisions of the Organizer Committee and the Technical Committee that will be unappealable.