SAUC-E Mission & Rules[1] (Version 01 – June 2013)
Competition date: June 28 - July 05 2013

The competitors for SAUCE'12 were 14 teams from 11 universities. This confirms the increased interest in this competition since 6-8 teams entered in the 2006-2009 editions, then 9 in 2010 and 10 in 2011. Thus far, 17 teams showed interest in the eighth edition of the competition. The following teams participated in SAUC-E'12:

- ECOLE POLYTECHNIQUE
- ECOLE de Technologie Supérieure (ETS) du Quebec
- ENSTA Bretagne – CISSAU
- ENSTA Bretagne – SAUC'ISEE and SARDINE
- ESIEA Paris – Aquatis
- ESIEA Paris – Ryujin
- University of Bremen
- University of Cambridge
- University of Florence
- University of Las Palmas de Gran Canaria - AVORA
- University of Luebeck – Hanse
- University of Luebeck – SMART-E
- University of West England
- Herriot Watt

Objective:

The goals of this competition are to advance the state-of-the-art of Autonomous Underwater Vehicles by challenging multi-disciplinary teams of students and engineers, to perform an autonomous mission in the underwater environment and to foster ties between young engineers and the organisations involved in AUV technologies. It is designed as a mini-grand challenge for the autonomous underwater community which will create a suitable environment for interdisciplinary interactions between academic researchers.
The new twist for SAUC-E'13 will be to fully include a second autonomous underwater or surface robot as a collaborator, there will be four main tasks but several sub-tasks that can bring points even though the entire task is not completed, and starting this year we require each team to provide a one-page summary with the most important features of their robot (both hardware and software/algorithms) in a form of a table. A sample will be posted on the SAUC-E web page. In addition this year there will be dedicated time slots for qualification defined prior to the competition. This will be done on a first come, first serve basis, the entries that pay the deposit first will have the later time slot. The success of SAUC-E contributed to winning the EU funding for the euRathlon (http://eurathlon.eu/) project: the world's first contest that will test the intelligence and autonomy of outdoor robots in demanding mock disaster-response scenarios which will culminate with the organisation of the joint 'grand challenge' covering all three (air, land, and sea) domains. A competition for land-based vehicles in 2013

[1] These rules are subject to change, refinement and development but will for sure be frozen starting the 1st day of the competition.

(http://www.eurathlon2013.eu/eurathlon_2013.html) will be followed by one for underwater robots in 2014 with the final competition in 2015. From year one workshops will be common to all euRathlon competitions (land, water and air) and will be held during the competitions, with the aims of both building a shared understanding of the major challenges of real-world robotics and cross-fertilising ideas across (often detached) research communities in land, water and flying robotics domains.
It is very important to state that SAUC-E and euRathlon are separate events although they might be organized back-to-back in 2014 and 2015 to ease the organization of the events. SAUC-E is the competition which welcomes new participants (up to the number which is the physical limit for the CMRE area) while euRathlon seeks multi-robotic domain teams and will most likely be more selective.
Starting in 2012, the Centre for Maritime Research and Experimentation (CMRE), formerly NATO Undersea Research Centre (NURC), under the sponsorship of the Office of Naval Research (ONR) and ONR Global, formed the NATO Engineering Support Team (NEST) for SAUC-E. The objectives of the team are: to help raise the SAUC-E competition to the next level to go beyond the state of the art in AUV technology, Subject Matter Experts (SME) to provide additional guidance the students in the design of the AUVs that can perform well in realistic environments, encourage collaboration among teams and help the teams to spend their limited budgets wisely.
The NEST has set up an online forum/wiki site where the teams can collaborate, share codes, and post issues/solutions; has purchased the AUV components for the Hardware Library that the competitors can borrow (they are available, please contact us); has written documents especially addressing the challenges of the SAUC-E environment; and provides email, phone, and on-site support to the teams. Many teams have loaned the hardware (modems, pinger) so far this year. All of these components will hopefully result in improved SAUC-E competitors AUVs, increased student interest in the competition, loaned sensors integration software and data from in-water tests posted on the collaborative web page and made available to all the competitors. NEST is open to suggestions from organizations interested in becoming actively involved in SAUC-E. NEST encourages, and will advise the judges to reward teams with members from multiple disciplines. Underwater robotics requires expertise in from various engineering domains (mechanical, naval architecture, control engineering, communication, etc.). NEST discourages the advisors (professors) from actively participating in preparing particular tasks during the competition and will recommend the judges to penalize such actions.

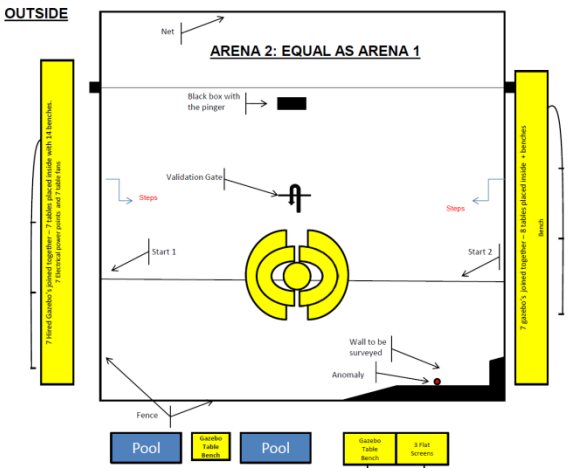

Figure 1: CMRE's Sea Basin

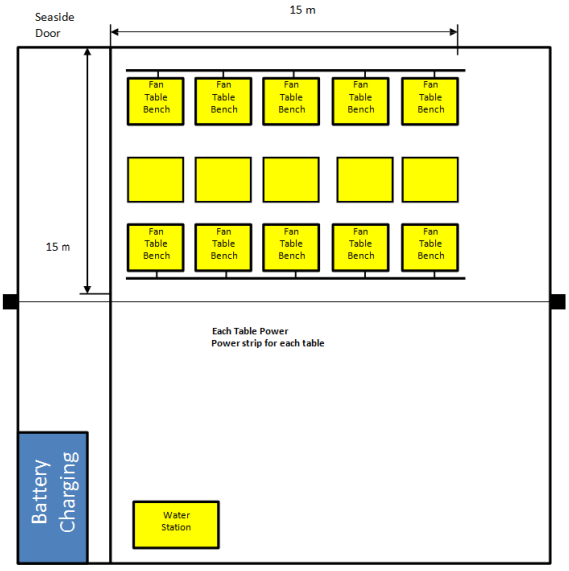

Figure 2: CMRE's Work area in B14

Figure 3: Gate Lights

Schedule:
The competition is planned to take place at CMRE, La Spezia, Italy, on June 28th – July 5th 2011. The facility is a sea water basin bounded on three sides by a wall and enclosed by a net on the fourth side. As for SAUC-E'12, the organizers are once again creating two equal arenas. Of course, Arena 2 will be bounded on two sides by the wall and two by the net, see Figure 1. The Teams will be based in Building 14 in a cleared area to the left of the seaward entrance, see Figure 2. Each team will be provided with tables and benches to work on and 220v power and multiple sockets. Each table will have a fan and a LAN connection.

Day	Date	Events
1	Friday, June 28	• Teams arrival and registration • Vehicle safety inspection • From 2pm - Mandatory familiarization meeting • Welcome barbeque 4 – 6 pm
2	Saturday, June 29	Practice runs – all day, start at 8 am • 7:30 – 8:00 am competitors arrive • Facilities for judges, observers, and media set-up finished • 5:45 – 6:00 pm daily debrief
3	Sunday, June 30	Practice runs – all day, arrival at 7:30 am, start at 8 am • 7:30 – 8:00 am competitors arrive • 5:45 – 6:00 pm daily debrief
4	Monday, July 01	Practice runs – all day, arrival at 7:30 am, start at 8 am • 7:30 – 8:00 am competitors arrive • 5:45 – 6:00 pm daily debrief
5	Tuesday, July 02	Practice runs – all day, arrival at 7:30 am, start at 8 am • 7:30 – 8:00 am competitors arrive • 5:45 – 6:00 pm daily debrief
6	Wednesday, July 03	Qualifying runs, slots specified – all day, arrival at 7:30 am, start at 8 am • 9:00 - 11:30 am Static Judging • 5:45 – 6:00 pm debrief
6	Thursday, July 04	Qualifying runs, slots specified – all day, arrival at 7:30 am, start at 8 am • 9:00 - 11:30 am Static Judging • 5:45 – 6:00 pm debrief
7	Friday, July 05	Final runs – all day, arrival at 7:30 am, start at 8 am (closing 6pm) • Media Day – all day • 7 pm Award Ceremony

The Challenge:

The AUV must perform a series of tasks[2] autonomously, with no control, guidance, or communication from a person or from any off-board computer including the GPS[3] system, as illustrated in Figure 1.

Task 1 (100%, all or none)
Move and submerge from the Start point 1 or 2. The teams will be allowed to specify vehicle's orientation. Pass through the validation gate[4] – without contacting any part of the 'structure'. The gate will be constructed of 2 orange buoys on a rope, 2 m apart (lights will be added to the ropes to aid the competitors, see Figure 3). The task is to traverse at the controlled depth towards the centre of the Arena, make a 90 degree turn, and pass through the validation gate. All teams must start from the South or North wall of the basin. The starting point of the vehicle will be located at least at 8 metres from the validation gate, as illustrated in Figure 1. The net which marks the end of the arena will be placed at least 5 meters from the gate. At that point Task 1 will be completed. **Failure to successfully negotiate the validation gate will result in the run being terminated. The negotiation of the validation gate will be the requirement for the final.** At that time the points for the first task will be awarded. A video log of the AUV passing through the gate must be provided. The gate will be marked by the two buoys (detectable both by the sonar and video camera), spaced 2 metres apart, and an anchoring line. The line will be illuminated by the lights, placed in a tube. Due to the low visibility in the basin the lights will be visible only from a close (1-2 m) distance but these conditions constantly change according to the weather (lighting conditions, sea state, water turbidity). In the centre of the Arena there will be a large landmark (made out of the yellow tubes used in the previous years to form the pipeline). The top of the landmark will be aligned with the gate. Thus, the top of the landmark can be used as a good point to make the 90 degree turn. The organizers reserve the right to change the size (length, width, and height) of the landmark during the competition.

Task 2 (33%, 33%, 33%)
Perform the "underwater structure" inspection. The structure will be constructed of 0.5 m diameter by 1.5 m cylinders as used in SAUC-E '10-12 to form a pipeline-like structure and are shown in Figure 4a. The structure will consist of cylinders arranged in concentric circles. A set of circles will be placed on top of another set to increase the height of the object. The structure will be placed on the bottom, will not be moved during the competition, and the top of it will be aligned with the validation gate. Thus, this structure can be used to make a 90 deg turn to be able to pass through the gate for Task1. Task 2 is to inspect this structure with an imaging sensor while maintaining a required stand-off distance from it. At that point Task 2 will be completed. After the AUV passes the validation gate it needs to go back to the landmark from task 1 and inspect it. The AUV can take any path to the landmark. Task 2 is to thoroughly inspect the underwater structure. The AUV might start from any point of the structure, may maintain any distance from it (to be decided by the team
based on the inspection sensors available, any sensors are allowed as long as they

[2] See definitions at the back of this document.
[3] GPS can be used while the vehicle is on the surface. The remote controller can be used to move the vehicle while on the surface in order to ease the job for the divers.
[4] The purpose of the validation gate is to show that the AUV can progress in a controlled manner, in a straight line, and turn when needed at a controlled depth.

supply good quality data), and any path planning algorithm for moving around the structure will be allowed. The points will be awarded based on the quality of the inspection data. 100 % coverage of the structure is desired and the inspection data from any sensor (team's choice) will be accepted. If equipped with the sonar the sonar mosaic or 3D structure reconstruction could provide a very good inspection product. If equipped only with the video camera, in order to get a good quality inspection data of the entire structure, the team might need to perform several circles around the landmark at different depths. The accuracy of the AUV motion and the FOV of the sensor will be crucial to obtain a good data mosaic, 2.5 D photo mosaic, or a 3D image reconstruction of the structure. The points will be awarded as such:

1) 1/3 of the total task points if the AUV performs a search around the structure while maintaining the structure in the FOV of a sensor (even one 360 deg. pass will be sufficient to get this partial credit). The structure will have a mark (detectable both by sonar or video) in order for the judges to be certain that the inspection was performed around the entire structure,

2) 2/3 of the total points if the AUV performs the inspection such that the 100 % coverage of the structure is obtained, and,

3) full credit will be awarded if the mosaic and/or 3D reconstructed image of the structure is produced.

The data must be provided to the judges within one hour from the end of the team's slot to encourage the teams to push their system to produce good quality data if not in real-time as close to real time as possible.

Task 3 (25%, 25%, 25%, 25%: Inspect the wall, find an anomaly, and call a friend to further inspect the anomaly):

The East wall of the basin must be followed. The objective is to maintain a position between 2 and 4 meters (<=4m and >=2m) from the wall for the duration of the survey. The AUV can use feedback from forward-looking sonar, altimeter, side mounted DVL, video camera, to name just a few sensors in order to maintain a constant standoff from the wall. The wall will not be straight.

An anomalous object (orange buoy with a light on top of it) will be placed close to the North and East end of the basin wall, as shown in Figure 1, at a depth not to exceed 1.5 m. The target will be a soft reflective object (both acoustically and optically) and will be a minimum size of 0.3m x 0.3m x 0.3m, shown in Figure 4b. The target will be of a distinctive colour and approximately spherical in shape. A mid-water target will be tethered to the ground by a light rope and have a strong white light source on top of it. The light will be turned on and off in intervals of not less than 10 sec., as was done for a mid-water target in SAUC-E'12. The task is to follow the wall and if the anomaly is detected the search AUV will send an acoustic signal[5] to the collaborator AUV (or ASV) to come and take a closer look at it and report on it. The collaborator - inspection AUV/ASV (initially positioned at Start 1, see Figure 1) must have a sensor that will be able to detect the buoy-anomaly and if the light (on top of the buoy-anomaly) is on or off and report this information to the search AUV during the rest of the Task 3 and during the time that search AUV is performing Task 4. During that time the search AUV will continue to send the information about the anomaly position (different message than the invitation message) until this message is acknowledged by the inspection AUV. The

[5] A compact modem (two of them), 20-24kHz, will be available for a loan from the Hardware Library. If this modem is used the judges will be able to listen to the messages. If any other modem is used, in order to get the points in case the collaboration fails, a team must supply a copy of the modem and software to the organizers.

teams might find it useful for the inspection AUV to keep receiving this message when it is close to the search AUV. Also, this way it can be scored separately from the inspection robot as this message can be heard by another modem in the water[6]. An inspection robot can be equipped with sensors and algorithms to detect the anomaly and might consider re-acquiring the anomaly (can be moved but it will be placed in the general area attached to the two walls as shown in Figure 1). In that case only the initial "invitation" trigger is needed by the search AUV. If an ASV is considered for the task a mechanism might be needed to be designed to bring the sensor close to the light source.

The point scheme and the sequence of sub-tasks is as follows:

1) 25 % of the total points if the search AUV follows the wall and finds an anomaly – correctly stops and images, maintains a distance from the anomaly (as done relative to the mid-water target in SAUC-E 10-12). These points are only given to the search AUV.

2) 50 % of the total points if the search AUV signals (the invitation message) the collaborator (another modem will be placed in the arena and the judges will be able to listen and verify the modem messages) and collaborator arrives within a 3 metres from the AUV. If the collaborator arrives in the location around the anomaly upon the invitation of the search AUV it gets the same points - collaborator bonus points in the scoring table. Thus, to get the credit for this sub-task and all other follow-on sub-tasks a collaborator robot depends on the search AUV as it must start its mission after it correctly receives the invitation message.

3) 75 % of the total points if the collaborator reacquires the anomaly based on the information provided by the search AUV (in order to save time and avoid collisions the teams might decide to send the appropriate information but vacate the area with the search AUV) – correctly stops and images, maintains a distance from the anomaly. During this portion of the task, the search AUV should send the message via an acoustic modem[6], reporting anomaly's x, y, z coordinates. Thus the search AUV does not inspect the light and will get this credit even if the collaborator does not achieve its goal as long as the position of the anomaly is correctly reported (anomaly position message sent and received by judge's modem). Thus, at this point, if all of the required functionalities are performed by the search AUV it can get 75% of the total points for this task. At this point, the collaborator-inspection robot can get 50 % of the total points for this task.

4) The data about the light being on or off correctly received and stored by the search AUV will result in the rest of the points leading to the full credit for this task. The collaborator AUV should report the information if the light is on or off[6]. For scoring purposes this means that the search AUV can get 1000 out of 1000 points (1500 if Tasks 1-3 performed in a continuous sequence) for Task 3 even if the full product regarding the collaboration fails – the reporting on light being on or off is not correct, as long as the acoustic messages are received at the correct time from the inspection AUV (verified by the judges). Thus, only for this portion of the task the search AUV depends on the collaborator and will not be awarded points if the collaborator does not fulfil the message sending assignment. Similarly, the collaborator-inspection robot can get maximum 750 out of 1000 as long as the search AUV does not fail to send the invitation message. The correct anomaly position is not necessary needed if the inspection robot can reacquire it in the general area.

It is ok to use GPS navigation at all the times for the ASV at all times. You need to be "invited" by the search AUV and then you can go to the general area using GPS nav. Buoy with light might be moved during the competition but it will be in the general

[6] A sample communication protocol will be provided by the organizers.

area so your ASV can perform the search for it. If a team collaborates with another team that uses a different type of modem, it would be acceptable to have a shore-based relay-station, which is simply a laptop with two modems attached that passes on messages between the different modems. This relay-station would also be used by the judges to monitor messages. It will also be acceptable to use the acoustic modem to remotely command a mission abort during the testing and/or qualification phases. In case of 2 teams collaborating each with one vehicle the teams be allowed to participate in Task 3 twice, once as a search vehicle and once as an inspection vehicle. And therefore a team can get up to 1750 points in total (when doing Task 3 as a separate mission). Task 3 performed with the single AUV (no collaborator) means there is nobody to report on the light being ON or OFF to you as you are alone, so there is no chance that you can store the data that does not exists and you can get 750 max. If there is an inspection AUV and even it is wrong in processing ON or OFF but it keeps transmitting an acoustic message as it should and you receive and log it you get the credit! **The teams should inform the judges prior to the run if they wish to cooperate. It should be noted that the judges will be able to listen to the modem messages ensuring that the points are awarded to either survey or inspection robot or both. Again, 75% of all the points will be awarded even if your collaborator completely fails in its mission as long as the search AUV meets all the requirements.**

Task 4 (33%, 33%, 33%)

Task 4 consists of three tasks:

1) Build a map of the environment (1/3 of the total points). Points can be earned for producing the map (1/3 of the total points) if the vehicle surfaces anywhere within the time limit. If it fails to surface within 3 meters of the black box, points will not be earned for surfacing near the black box.

2) Find a stationary black box, which may be placed anywhere in the arena (1/3 of the total points). The black box will emit a ping and will be placed in a camera- or sonar-detectable housing. The AUV can choose how to search for the box (detecting the pings or surveying the area with a camera or sonar sensor). If it both completes the survey and detects the pings (uses both methods), it is eligible for a 250 point bonus. The omnidirectional pinger will ping 1 pulse per second, at the frequency of 15 kHz, will have the pulse length of 10 ms, and will have a power output of 153.5db at 1m.

3) Surface in the surfacing zone within 3 meters of the black box (1/3 of the total points).

Thus, one third of the point will be given if the black box is found, one third if the map is created, and one third if the surfacing above the black box is performed. For Task 4, in the single-mission run in the final, the teams do have to perform the search using both methods to gain the bonus points. You can get these bonus points if you complete the search by both methods in separate missions as well. The vehicle has to return to the start point, it is ok to arrive to the general vicinity (5 meters) from the start point. The black box can be moved at any time during the AUV mission. **The surfacing must be attempted last.**

Each team will produce a log file of the mission within around 10 minutes of the end of the run. The format of the log file will be a comma separated ASCII file of the format: Time, position, action, a comment between simple quotes.
(SSSSS,XXX.x,YYY.y,ZZZ.z,AA.aa). Logged data will be plotted by plotting routine written by the organising committee. This will be used to score the log file. For the acoustic modem task the additional file of AUV heading and light on/off data and

cooperative AUV heading command will need to be provided. For the ASV tracking task the additional file of range and bearing data from the AUV to the pinger will need to be provided.

NOTES:

- Submerge and the validation gate MUST be undertaken first. The other tasks may be undertaken in any order.
- Tasks may be attempted individually from a start point requested by teams. Points can be collected for the successful completion of tasks throughout the practice days, qualification, and final[7].
- For completing all the tasks in a single joined up mission, extra points will be awarded, see scoring section.
- Between subsequent entry runs the in-water targets may be moved in position and/or depth.
- The vehicle MUST remain fully submerged. **Surfacing at any time will result in termination of that mission.**

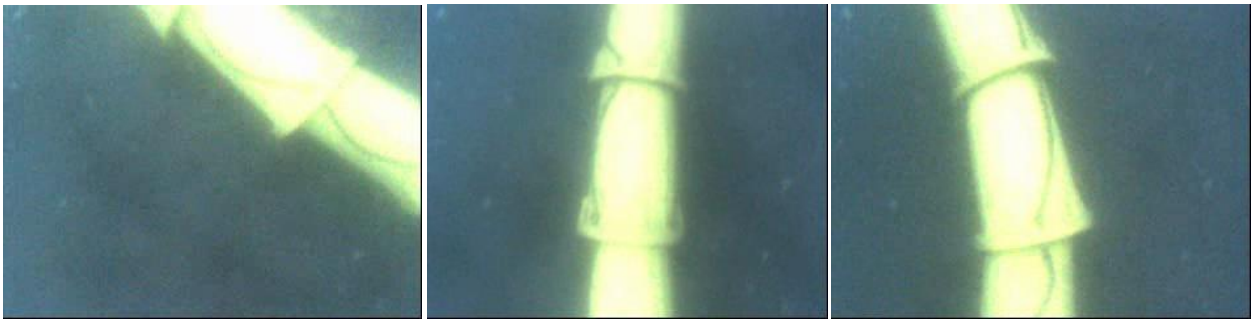

Figure 4a: SAUC-E 2011 Luebeck's pipeline following: detection, following the straight portion, and following the curved portion.

Figure 4b: SAUC-E 2011 Bremen's buoy servoing: detection, initial lock on it, final tracking and circling around it. This will be an anomaly for Task 3 in SAUC-E'13.

[7] Points for completing an individual task will only be awarded once for that task.

Timing:

- Each team will be allocated a time slot for their in-water run(s). Twenty minutes before their allocated slot the team may move their vehicle to a specified position near to the launch point.
- At the beginning of their allocated slot the team may move their vehicle to the launch point.
- Each team will have a maximum of 50 minutes to perform the mission (Depending on the number of finalists, the teams may have 60 minutes in the Finals). Prior to the mission slot a team has 10 minutes as the preparation period. The team may request that the vehicle is deployed in the water during this 10 minute preparation period. The officials may reissue tank time if the vehicle is not in the tank at the end of the preparation period.
- Only the judge can signal the start of operations. Only competition officials may deploy and recover the AUV. This is to prevent unsafe actions in an attempt to speed the deployment and recovery processes.
- A team may attempt multiple runs during the 50 minute operations period. Once a team has the officials deploy their vehicle, all points earned in previous runs (within this time slot) are lost. Only officials may retrieve a vehicle and return it to the dock.

- The mission ends when any of the following occur.
  - The 50 minute in-water period ends.
  - The Judges order the end of the mission.
  - The Team leader requests the end of the mission.

Venue

The competition will take place in the tidal basin at the CMRE, La Spezia. The area can be viewed in Google earth at 44.095842,9.864575
The basin is 120m long and 50m wide, the constant depth is 5.5 msw. The currents are negligible and the water clarity can be seen from the available images of the competition web site. The salinity can be measured and made available to the competitors if required. Competitors should be aware that there is a source of fresh water coming out of the wall close to the mid-water target, simulating a river delta. The AUV buoyancy compensation needs to be considered. Tidal range is approx 10 cm on a spring tide. Ambient water temp in June /July is approx 20° Celsius. The competition area will be 60m x 25m in the centre of the basin. The centreline will be marked by a visible reference on the sea bed. Water visibility varies between 1 and 2 metres depending on weather conditions. Magnetic compass behaviour is indeterminate at this stage. However we expect magnetic compasses to be useable 1 metre away from any structure. More information will be provided to you shortly.

- Each team will be allocated a preparation space and the following resources:
  - ~6 square metres of clear floor space.
  - Workbench/table/work surface.
  - A tent to work outside
  - 220v mains electricity supply.

  Notes:

  The preparation area may be a tent, container or similar temporary structure/enclosure. If a team decides to provide their own ‘structure’

(eg container) they must notify the competition officials well in advance of the competition.

- The teams will have access to the following communal facilities:
  - Internet connection for computers
  - Arena 2 area for testing vehicles away from the competition arena.

Notes:

- Teams must provide their own consumables, hand tools, drill bits and test equipment etc.
- All team members must be skilled in the operation of all tools and equipment utilised.
- Only low voltage battery powered tools and equipment will be permitted within 2 metres of the pool.

RULES

The official source for all information concerning rules, interpretations, and information updates for the 2013 Student Autonomous Underwater Challenge Europe is: http://www.sauc-europe.org/ and http://www.facebook.com/pages/SAUC-E/173111869367586?ref=tn_tnmn.

Teams may comprise a combination of students, faculty, industrial partners, or government partners with a maximum of 10 people per team. Students may be undergraduate and/or postgraduate students. Inter-disciplinary teams are encouraged. Members from industry, government agencies (or universities, in the case of faculty) may participate, however full-time students must comprise at least 75 percent of each team. The student members of a joint team must make significant contributions to the development of their entry. One member of the team must be designated as the 'Team Leader'. The Team Leader, and only the Team Leader, will speak for the team during the competition.

An 'Intent to Compete' form is available on the web site. A refundable deposit of 500 euro is required to be submitted together with the form. The form should be submitted by **May 15, 2013.** A formal 'Competition Registration' form will be available on the web site. This is due not later than **May 15, 2013**. The submission must be in English. The organisers reserve the right to limit the total number of entries that are allowed to compete by declaring the competition closed to new entries before the due date above. As with all official information, this announcement (should it be necessary) will appear on the official web site.

Vehicles

Each entry must be autonomous. Whilst carrying out the mission, no communication between the entry and any person or off-board computer is permitted. This includes the GPS system.

Weight in air and size constraints (tested at launch):

Maximum dimensions: 2m long x 1m wide x 1m high. Weight requirement:
The total system weight will be considered. This means that the cooperative /

collaborative robots total weight will be considered. This might influence the teams to look at either: 1) building a smaller AUV, 2) building the appropriate size/weight ASV, or 3) cooperating with another team that might be a good match, not only based on the robustness but also considering the weight factor. The weighting will be considered for search AUV as a main component in case of heavy search AUVs. This means that if a team finds a collaborator that is that is much lighter (or builds a light weight collaborator robot, ASV or AUV) it can avoid the penalty. Thus, the creativity in the design of new robot or choosing the appropriate collaborator can compensate for the heavy design. In case of the light search AUV collaborating with the heavy system the weight constraint will only be applied for the search AUV and therefore it can get bonus points as this is the objective of the weight requirement. This was decided for this year only as, again, the teams are advised to builds smaller, lighter but equally capable systems. When you do the math you will see that there is much greater award for collaborating then utilizing the weight bonus and going on your own. We have two vehicles, a search and an inspection. In case the search is a heavy one, say 50 kg, and the inspection is the lighter one, say 35 kg then the their weight is added for the system weight and the search AUV is penalized (Team X = 85 kg). Later in the day when it is the turn for the same two teams to collaborate but this time 35 kg vehicle is the search one the system weight to be taken is only the lighter one (Team Y = 35 kg). Again my idea is to help out the "heavy" robots for this year only (transition year, many examples that the heavy systems could not catch up in the finals even though they were in the lead going into the finals) but still encourage ALL the teams to come with the lighter systems in the future years. The weight constraints are summarised in Table 1.

Weight	**Bonus**	**Penalty**
System Weight > 90 kg	Disqualification	Disqualification
90 kg $\geq$ System Weight > 70 kg	N/A	60*(X kg-70)
70 kg $\geq$ System Weight > 45 kg	9*(70 - X kg)	N/A
System Weight ≤ 45 kg	225+9*(45 - X kg)	N/A

Table 1: System weight point allocation

Power constraints: All entries must be battery powered. All batteries must be sealed. The open circuit voltage of any battery in an entry may not exceed 60 Volts DC.
No materials (except for compressed air) may be released by the entry into the waters of the Arena. Any vehicle leaking a fluid will be deemed unsafe. All vehicles must carry a clearly legible ‘label’ showing the vehicle weight in air. All vehicles must have 2, 3 or 4 clearly identified lifting points onto which standard commercial lifting slings may be easily attached / detached – on land or in the water – in a safe manner.

All vehicles will be required to install strobe lights.

All entries must bear a clearly marked OFF switch that a diver can readily activate. The switch must disconnect the batteries from all propulsion components and devices in the AUV. Note that this does not have to kill the computer. Upon reactivation, the vehicle must return to a safe state (props do not start spinning). All entries must be positively buoyant by at least one half of one percent of their mass when they have been shut off through the OFF switch.

Competition officials will be responsible for recovering lost entries.

The officials will suspend the operation of a vehicle at any time they deem that such action is required by safety or security considerations.

Teams will be required to submit technical descriptions of their entries to the officials in advance of the competition, with the goal of identifying potential safety concerns well in advance. When requested, such technical information submitted to the judges will be held in confidence until the end of the competition.

Any vehicle deemed unsafe by the competition officials will be disqualified.

Journal Paper

Each team is required to submit a Journal Paper that describes the design of their entry and the rationale behind their design choices. This paper may be no more than **20 pages** (including all figures, references, and appendices but excluding Resumes). The paper must include the following sections:

- One page Robot Description (the sample will be posted on the web)
- Executive Summary
- Introduction
- Description (Physical, autonomy and mission planning)
- Innovation
- Financial summary (1 page on income and expenditure)
- Risk Assessment

The paper must be provided in electronic format (pdf preferred). The format shall be printable on A4 sheets, margins of at least 25mm all sides, 10 point font or larger. Journal papers will be collated into SAUC-E proceedings which will be made available on the SAUC-E web site. The Journal Paper will be evaluated as described in the section on scoring.
A video diary will be accepted as a supplement to the journal paper. The video diary should focus on significant events during your preparations for the event. For example, team meetings, designing, building, testing etc. The video will be collated to form part of a competition video and / or displayed during the event.

The paper must be received not later than June 21, 2013. Teams that do not meet the submission deadline will not be allowed to participate in the competition.

Resumes of all student team members should be appended to the journal paper.

Static Judging

Each entry will be subject to static judging. Each team will be requested to give a 15 minute presentation which will be followed by questions. The presentations should be delivered by student team members (not professors). The judges will evaluate each entry on technical merit, safety and craftsmanship, as described below in the section on scoring. These presentations will be scheduled in advance. Teams are also strongly encouraged to make a poster describing the entry. Representatives of the press and of other organisations will be encouraged to visit each team.

Scoring
Entries will be scored on performance measures and on subjective measures, these are detailed in Table 2. Points for attempting tasks in multiple missions can be acquired throughout the week. Points for a single multitask mission will only be allocated during the final.

Performance Measures		***Multi mission Task Success***	***Single Mission Points For Attempt** (From file / From Judges)***	***Single Mission Task Success***
Weight	See Table 1			
Pass through Validation Gate		150	150	150
Structure Inspection		100+ 100+ 100	250 / 50 (300 max)	600
Follow Wall & Find Anomaly + Invite and Arrive*** + Reacquire Anomaly + Report and Receive		250 + 250 + 250 + 250	900 / 100 (1000 max)	2000
Black Box + Map + Surface		250+ 250+ 250	700 / 50 (750 max)	1500
Bonus – Collaborator***				750
Bonus - Dual Black Box				250
Subjective Measures		***Max. Points***		
Journal Paper (J) + Video (V)			200 (J) 100 (V)	
Technical Merit (From Journal Paper, Static Judging + Observations)			500	
Craftsmanship (From Journal Paper, Static Judging)			500	
Safety of Design (From Journal Paper, Static Judging)			500	
Innovation (From Journal Paper, Static Judging)			500	
Impress the judges			500	
Discretionary Points (Awarded After Last Competition Run)			300	

Table 2: Scoring Matrix

Note that an 'attempt' must appear in the Log file or, in the opinion of the judges, be an obvious attempt to complete that part of the mission.* Credit for the arrival, re-acquisition of the anomaly, and the reporting about the light is available to the collaborator robot.The Log file points will be allocated after the run when the log file of the vehicle is used to replay the mission in simulation and evidence of autonomous decision making (i.e. not luck) is demonstrated.

Journal Paper, These points are for the production of the journal paper, ensuring all sections are included and the amount of thought and care that has gone into its production.

Technical Merit, The vehicle will be assessed on overall design, software algorithms, mission planning, design choices addressing the problem and construction.

Craftsmanship, These considerations will account for any components of the design that are or could be (in the judges' opinion) commercially available or do not include a significant contribution by team members. In other words, if you use a well-built, well-designed, off-the-shelf computer, your team does not get points for the computer's good technical design, etc. You will get points in the Technical merit section for selecting a computer that is well-suited to the engineering needs of the design, in the opinion of the judges. Efficient and novel use of cheap 'every day items' will also gain points.

Safety of Design, Points will be awarded for knowledge and resolution of potential hazards in the vehicle's design. Judges will be looking for the team's recognition of potential hazards and how these hazards have been removed or managed in both the design choices and final vehicle.

Innovation What makes your vehicle unique? This section is looking for the new ideas, be it something built specifically for the competition or a novel use of existing equipment.

Sequence of Events during the Competition

Static Display Period. Each team will receive a scheduled time during day 2 or 3 of the competition for static judging. In addition, judges, members of the public, the press, and representatives of other organisations will also view the entries and talk with team members throughout the event.

Practice Runs. Practice time slots will be scheduled to achieve maximum utilisation of the tank. The size of the Ocean Basin permits multiple courses. Each entry must be approved by the judges before it will be allowed into the Arena. Our objective is to provide as much practice time in the water as is practical. We expect to allow several entries in the tank simultaneously, on the condition that they do not interfere with each other. It is anticipated that each team should have approximately 6 hours of practice time.

Competition. Each team will be assigned a time slot for their preliminary/elimination run. This is planned to be the afternoon of the 4th day. The final runs, envisaged to take place on the last day, may be restricted in numbers – dependent upon time available.

Awards

TBC

Definitions

Mission – A mission is defined as an attempt at completing one or all of the predefined tasks. A mission is started when the vehicle submerges and ends when the vehicle surfaces.

Tasks – Tasks are a specific challenge; go through the validation gate or dock in the docking station are two individual tasks.

LIABILITIES & RESPONSIBILITIES: The organizers of SAUCE '13 assume no liability for the competitors. The organizers will perform the safety inspection of the competition area with the organization's safety officer prior to the competition. The competitors will not be allowed to dive.