Application of Protei to Tech Awards

Cesar Harada nominated to apply to represent the Protei team.
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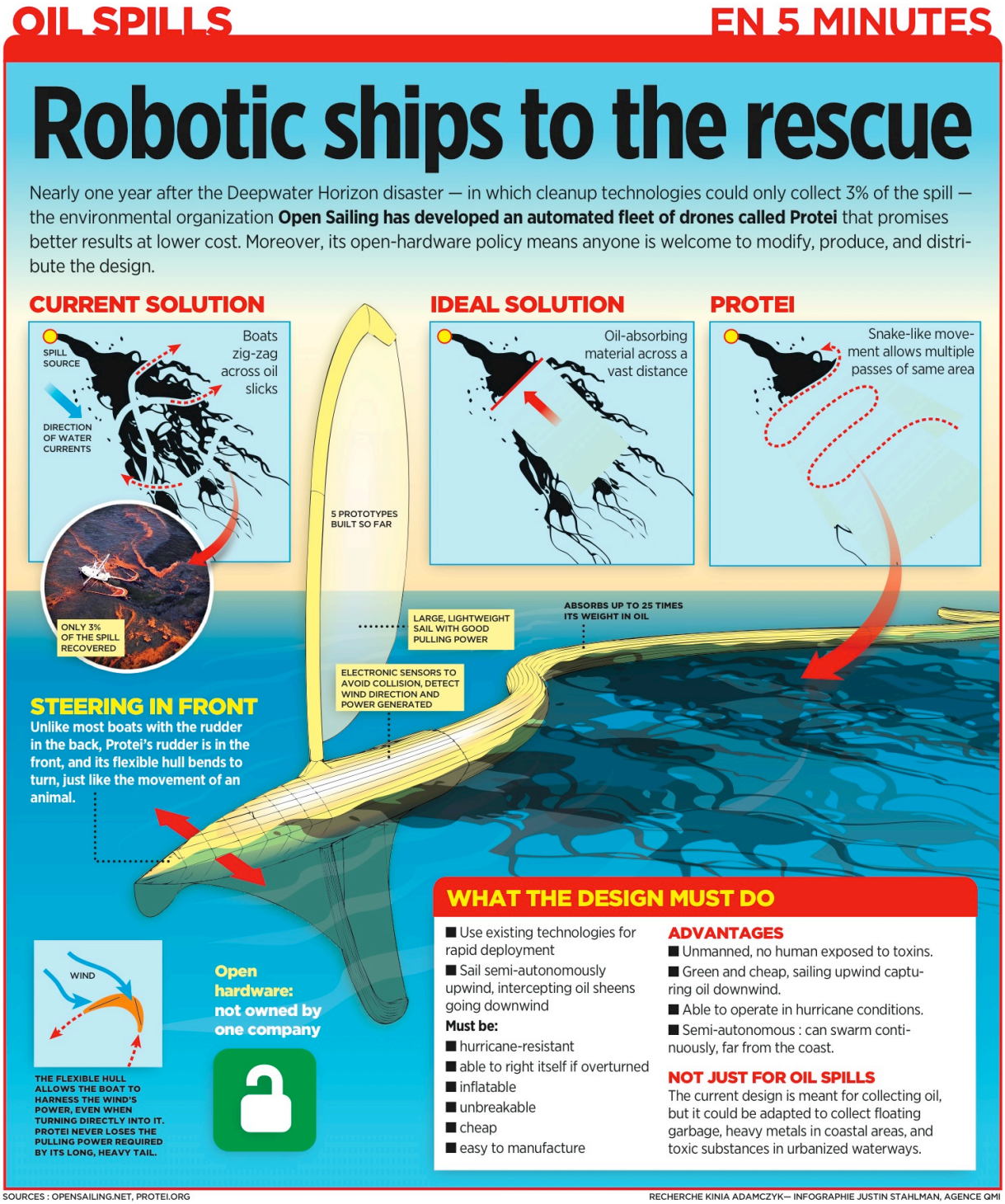

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Problem Identification

What serious problem or challenge with broad significance does your use of technology address? Explain the context in which your technology operates.

Protei is a transport platform, constructed to carry research instruments or environmental clean-up equipment while traveling autonomously long distances on the ocean using wind power. The technical particularity of Protei over other sailing robots is it's shape-shifting hull : it has neither rudder nor centerboard, but rather changes shape to control its trajectory and pull its payload behind like a "long tail".

General context

Human population has grown exponentially over the last century, leading to a growing need for food, energy production, and wide spread use of synthetic chemicals. An increasing body of evidence suggests that the proliferation of pollutants is resulting in a nearly ubiquitously contaminated global environment, permeated at every level by the by-products of civilization. The oceans are the lands dumpsites and are under unprecedented stress.

Oil spills

Protei was initially developed during BP's Deepwater Horizon oil spill to mitigate environmental impact. Cesar Harada was working as a project leader at MIT where he was spearheading development of a robotic oil spill cleaning device. In the MIT lab, his team was designing an expensive, patented, fossil fuel powered technology for future implementation. Harada decided to leave Boston, relocating to the Gulf and spending the next two years working on the front lines of the crisis to develop an alternative Open Hardware technology that would provide an inexpensive, non proprietary, and more immediate solution, powered by renewable energies. After careful observation of oil movement patterns and working with local residents and fishermen, the concept of a shape shifting hull to tow oil absorbent was born and named "Protei".

When BP's Macondo well began gushing crude oil into the Gulf of Mexico in April 2010, skimmer ships pulling sorbent booms were immediately deployed. Estimates show that these manned vessels collected approximately 3% of the surface oil. "The Times-Picayune", a Louisiana newspaper, published photographs of crude oil that washed onto a 200-mile stretch of gulf coastline as recently as April 2012. As the U.S. Oil Spill Commission's Final Report puts it, "The Deepwater Horizon oil spill… is an acute human and environmental tragedy… [requiring] not months, but decades of national effort to address and repair."

While there is no cure for environmental catastrophes of this magnitude, the adverse effects of such events would be mitigated by the ability to quickly and effectively remove larger quantities of oil from water following a spill. Later we will discuss how our technology changes the status quo of oil spill response, empowering humans to immediately reduce contaminants with greater efficacy and fewer risks to human health.

Protei was designed, prototyped and tested initially in New Orleans in a garage by Lake Pontchartrain. Protei is now developed by a vibrant international community for a variety of applications beyond oil spills.

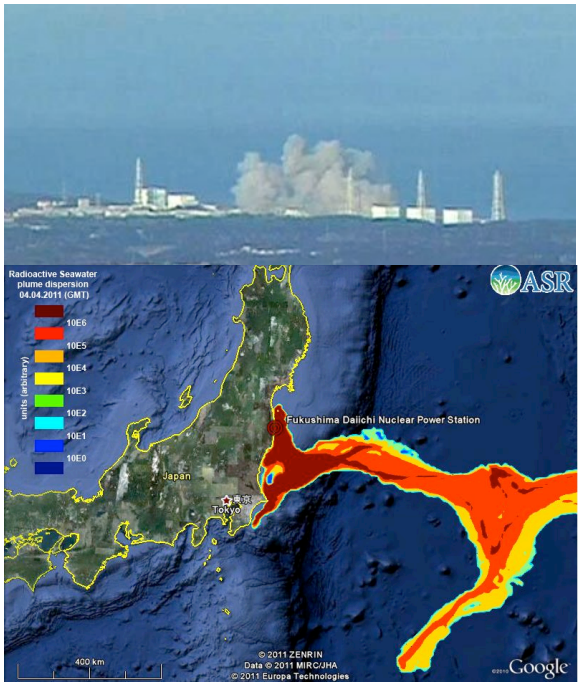
Plastic Debris

A key example of the far-reaching effects of anthropogenic pollution is the Great Pacific Garbage Patch, where ocean gyres have assembled state sized masses of plastic particulates, and photodegradation is infusing ocean water and neustonic organisms with more than 5,000 grams of known pollutants per square kilometer. Research on the subsequent biomagnification points toward increasing accumulation of related toxins in zoo- and phytoplankton, pelagic fry, birds and cetaceans, eventually permeating global food webs leading to increased toxic load in humans.

Even if we stopped producing plastic today, it would take several decades for it to break down and accumulate. We need to develop technologies that will be able to capture plastic at the same rate as it is being generated and transported. Today no efficient passive, or renewable energy-powered cleaning technology exists to perform this decades-long duty in the middle of the oceans.

Radioactivity

The known adverse environmental impacts of the nuclear disaster at Fukushima following the Tohoku earthquake and subsequent tsunamis in March 2011 continue to increase. Recently declared a Level 5 crisis responsible for “several radiation deaths” by the United Nation’s International Atomic Energy Agency, the Fukushima disaster is a stark reminder of the delicate balance between human ingenuity and nature’s unpredictable variables. While we may not have the option to remove radiation dispersed from crippled reactors and damaged nuclear cooling pools, technology can and should play a role in helping us map the path of radiation spread by ocean currents along Japan’s coastline, into the Pacific, and eventually onto foreign shores. By increasing our understanding of where water and marine life will be most heavily impacted, and predicting where currents of radiation will make landfall, we are at least empowered to act preemptively to mitigate the lasting effects of this environmental disaster. Our technology has already been tested on the ground in Japan, and has the potential to contribute to continued surveillance and mapping of radiation dispersal at sea.



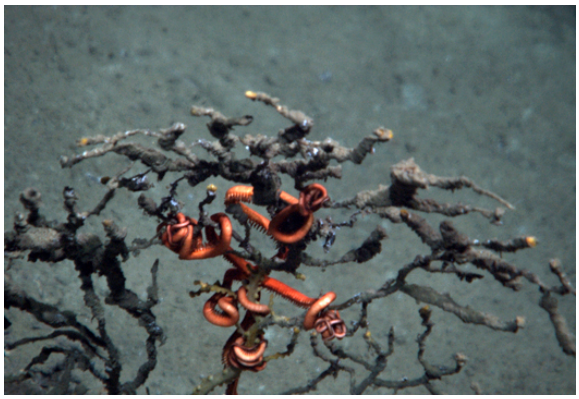
Overfishing

Almost 80% of the world’s fisheries are fully to over-exploited, fully depleted, or in a state of collapse. Worldwide, about 90% of large predatory fish stocks are already gone. The loss of biodiversity jeopardizes the balance of entire ecosystems as well as an important human food source; not to mention, handicaps the world's largest CO2 offsetting pump - the oceans.

A key example of overfishing happened in 1992 in Newfoundland, Canada. The once thriving cod fishing industry came to a sudden halt as no cod appeared. 40'000 people losing their livelihood and an ecosystem in state of decay. In present days the fishermen are still waiting for the cod to return. Today, many fish species are under similar threat as our fishing technology improves and demand only grows. We need to develop tools to appropriately assess and manage fish stocks with fleets of measuring instruments.

Algae Blooms
An algal bloom is the rapid increase of algae, typically microscopic phytoplankton. While many blooms are begnin, some large events are made of harmful phytoplankton such as dinoflagellates of the genus *Alexandrium* and *Karenia*, or diatoms of the genus *Pseudo-nitzschia*. In some cases the blooms induce the production of neurotoxins that can cause mass-mortality in fishes, seabirds, sea turtles and marine mammals like dolphins and whales. In turn human can get sick or even die if ingesting contaminated seafood. Another chemical consequence is oxygen depletion (hypoxia or anoxia) from cellular respiration and bacterial degradation. As with the need for fish stock assessment, Protei can provide a distribution platform for sensors studying the often large and complex formation of algal blooms.

Coral Reefs
Coral reefs are known to be some of the most precious biodiversity reserves in the world. Many of them are now suffering agricultural and industrial runoff, increased sedimentation from land clearing, direct exposure to human sewage, herbicides, pesticides, fertilizers and animal feed lots. These are often manifested through an abnormally high presence of contaminated nitrogen and phosphate. Coral reefs represent an enormous economic asset for tourism, as well as an efficient natural coastal barrier, hosting large quantities of fish stocks as well as grounds for medical research.
Many coral reefs are located in developing countries and the costs associated with studying and protecting them is often unaffordable for local authorities and residents.



General Oceanography and Natural Reserve monitoring
Currently, the most popular general oceanographic/ climate monitoring device is the ARGO "global array of free-drifting profiling floats (~3500 units) that measure the temperature and salinity of the upper 2000 m of the ocean in or near real-time." Each of these units typically spends about 10 days underwater and surfaces for a few hours to communicate to satellites, meaning we only get surface data for a few hours every 10 days from each unit. Being a passively drifting profiling device, we cannot decide where to position the drifter. What if were able to have constant real-time surface data? What if we were able to have constant surface communication, and to dynamically reposition our sensors based on real-time data streaming? We would get more accurate climate simulations and be able to more precisely monitor sensitive areas such as natural reserves. Small unmanned silent sailing robots would also be less intrusive on animal populations and would be capable or sailing back of periodic maintenance and sample analysis.

General statement
It is likely fair to say that for as long as humans have coalesced into civilizations, we have subjected ourselves to the detriments of our advancement. Environmental disasters and the impact of society's wastes – natural, chemical and synthetic – are the shadow cast by industrial progress. However, never in our history on earth have we been so capable, through unforeseen variables or sheer naivety, of causing such far-reaching – indeed global – consequences. Our goal is not to stem the natural flow of society's evolution, but rather to harness the fruits of our own innovation – technological ingenuity and creative design – to ensure we are equally capable of preserving the integrity of our resources and environment. In response to the following questions we will demonstrate how our technology is at the nexus of innovation and preservation, coupling existing technologies with ground-breaking design to provide a powerful, pluripotent tool with far reaching applications to the control of environmental contaminants.

Technology Innovation

Please describe your technology, or novel application of an existing technology, with emphasis on the innovation(s) that you have contributed. How is your new technology or application distinctive from previous solutions addressing the same or similar problems?

Ocean workhorse

The idea behind the development of Protei is to develop a powerful and versatile platform, a true workhorse for ocean sensing and cleanup. Protei will not provide the fastest transport, nor the strongest but we are trying to make it dependable, modular, safe and affordable. Essential characteristic of Protei is that it it self-righting, unsinkable and collision-safe with its flexible hull. Since the goal of Protei is long term deployment, energy autonomy and efficiency are also very important factors. But these are rather common concerns for autonomous sailing vessels - what makes Protei so special is its shape-shifting hull.
Our hypothesis is that a shape-shifting hull would provide superior mechanical, control, energy properties to a sailing robot. We have not fully proven these points yet but by testing our successive prototypes we have observed very promising behaviors.

Shape shifting hull physics

_ Trajectory control

We have observed that a shape-shifting hull provides better trajectory control and dynamic stability.

_ Maneuverability

A shape shifting hull decreases the radius of jibing and tacking. With 2 sails, it guarantees the vessel is never stuck in irons, the 2 sails being at different angles to the wind when the hull is bent. This also means that minimizing the loss of speed and pulling capacity on the payload behind.

_ Lateral Lift

At high speed we expect our bent profile to behave as a lift surface. This would mean either sailing closer to the wind, or further away.

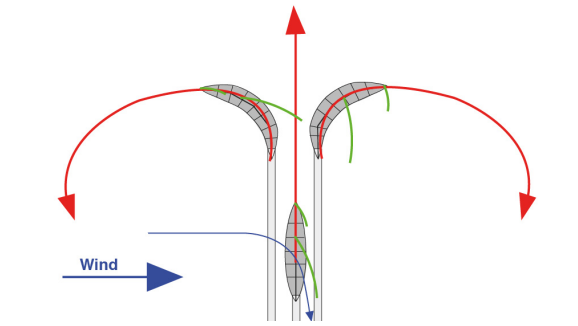
_ Efficient profile : no centerboard, no rudder

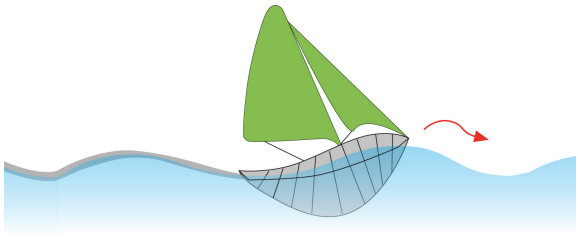
Protei entire hull bends, removing the need of a centerboard or a rudder. Would that result in less resistance and less turbulences?

_ Absorbing environmental noise

Rigid hulls get “slapped” by waves when Protei bends and follows wave motion.
Would this “noise reduction” system allow faster forward motion?

Protei_002 built in New Orleans





Electro-mechanics

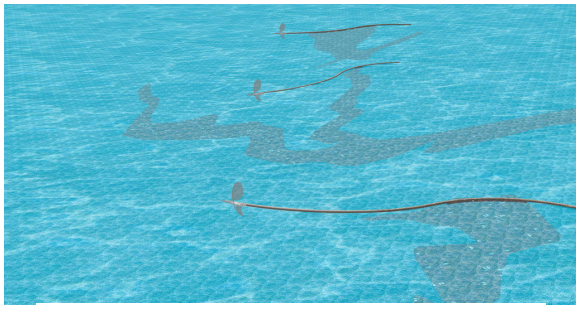
_ Actuating a large surface

Actuating large surfaces requires usually a lot of energy. Fishes actuate their entire shape and they are more energy efficient than turbine-powered optimal-shaped torpedo. Can we actuate the shape of Protei using less energy than a turbine?

_ Correcting point of sail

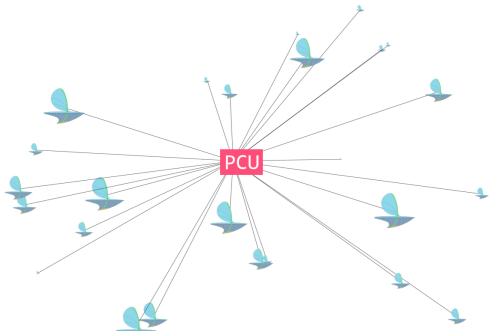
Since centuries in the Pacific, many traditional outriggers have had asymmetrical hulls that are excellent at keeping a steady point of sail : could we reduce energy expenditure by having a hull that’s excellent at keeping it’s point of sail Here is a Proa

Swarm behavior
As we scale up in the range of applications Protei would address, the idea is not to have larger Protei units, but operate many small Protei as a swarm of robots. Coordination is crucial to execute search or scanning routine, as well as to optimize sailing trajectories to collect pollutants. Similarly to the way quadrocopters are now used for swarm experiments, our plan is to make highly maneuverable sailing vessels at low cost to be able to "risk" them for large scale swarm experiments involving many units on the water.



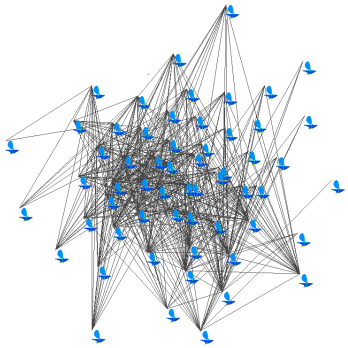
Distributed computation & Robustness
We have in mind a clear evolution of the communication and computation architecture of Protei.

_ 1. Remote controlled
Our first focus is to get units that would navigate simply remotely controlled either with a simple RC kit, or using an Iphone or Android at sight.



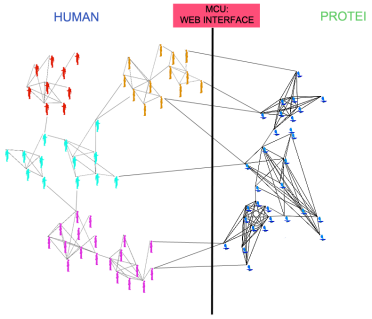
_ 2. Autonomous from sensors
Once Protei gets beyond the horizon it becomes necessary each unit senses its environment and optimize autonomous navigation behavior from environmental parameters (GPS way points, Wind, currents, waves) and the position of other units.

_ 3. Centralized network
Once each unit is capable of autonomy, next stage is the coordination of a swarm of Protei, all the units being controlled by one central computer on land.



_ 4. Decentralized Network, Protei to Protei
To improve the robustness of the system, the decision-making system needs to become decentralized so each units knows where other units are and makes informed independent decision. That means significantly higher computational capacity on board for each unit. The Android platform and the processing capabilities of a modern mobile phone are enough for this control task.

_ 5. Multi-player Online
The ultimate stage would be to have a robust decentralized autonomous system and real-time data communication with each unit, so the Human Protei community of on-line gamers would be able to override and control autonomous behavior of either a single unit or sub-group to operate Protei units for targeted tasks. We would use inter-operable multi-player gaming engine on video game consoles, desktop computers, laptop computers, and mobile devices and tablets.



Artificial intelligence
Protei artificial intelligence group innovates as much in the structure of the real-time database as much as in how much energy is used to access and process data. The computational processes have been dispatched into 3 levels of complexity corresponding to 3 levels of energy requirements and attributed hardware resource.

_ Unconscious : Past, Survival.
We will use the analogy of the beating heart : it is the vital functions of Protei that do not require complex computation. That's the layer where Protei anti-flooding pumps, positioning and emergency systems live.

_ Semi-conscious : Present, React to environment
We will use the analogy of the breathing lungs : they are operating automatically but we can take control over the process when we need to. That applies mostly for point of sail correction, for the permanent little adjustments that make Protei functions.

_ Conscious : Future, Decision Making, Strategy
We will use the analogy of hand motion : making delicate maneuvers or taking complex decisions requires a lot of computational capacity. Even higher decision-making or strategy-building involves understanding position, aim and speed of all the other Protei units coordinating to either sense or clean up as a swarm.
The same levels or channels that are used to actuate Protei and get sensory feedback would be used to distribute acquired data for machine learning.

Description of Technology Application

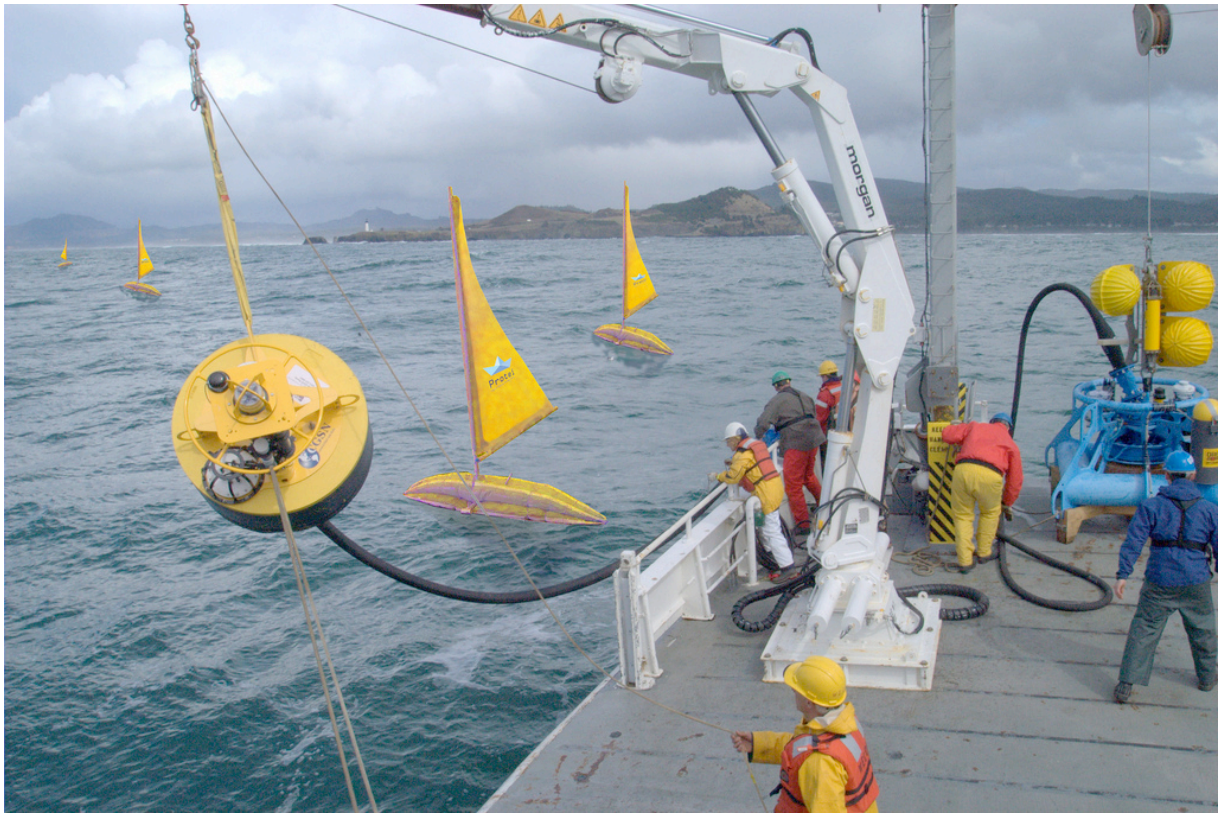
Fully describe the technology application. What technology is being used? How is it being used? Who is responsible? Who is benefiting? What processes or systems are in place to deliver this technology application?

Protei is a shape shifting sailing robot developed Open Hardware to sense and clean the oceans. It will be used to sense spilled oil, radioactivity, plastic debris and also study algae blooms, monitor coral reefs, fisheries, used in coordination of subsurface vehicles and general oceanography.

One technology, 2 sizes. Protei 1m, Protei 6m
We do not need the same machines for sensing and for cleaning the ocean. A Protei that is carrying simple oceanographic instruments will only be 1m long, whereas a Protei that needs to pull several hundred liters of oil booms will need to be at least 6 m long. While collecting oil remains our long term goal, Protei can serve many other purposes more easily, so we'll develop the small Protei, extensively tested it before we scale it up.

- 1 meter (~ 3 feet) for sensing. Highly functional prototype release Sept 2012. Beta Product Dec 2012. The same hull can be upgraded from the status of "toy" (blue above), to carry high-performance scientific payload (in yellow down).
- 6 meters (~ 20 feet) for cleaning. Prototype June 2013. Beta Product Sept 2014.

Simulation : Protei 1m Remote Control, performing oceanographic studies



Simulation : a fleet of 6m Protei carrying heavy scientific payload.

Decentralized R&D : Open Hardware & Aggressive Testing
Protei is developed by an international community of makers. We are using Open Hardware and our tactic is to build and test as often as possible.

Manufacturing : Appropriate technology & Rapid prototyping
We want our technology to be pervasive and adapted to local materials and customized for local applications and issues. Same way R&D is decentralized, manufacturing, operation and customer service will be decentralized.

The Protei team is global, we can build and test Protei units in several locations :

- USA, San Francisco, Tech shop, Cesar Harada.
- USA, New York, ITP, Gabriella Levine.
- USA, New Orleans, LUMCON, Lake Pontchartrain, Cesar Harada.
- UK, London HackSpace, Goldsmiths University, Kasia Molga.
- Netherlands, Rotterdam, V2_ Institute for the Unstable Media, with Piem Wirtz.
- Netherlands, Eindhoven, Institute of Technology Eindhoven student group.
- Germany, Berlin, Superkubus with Sebastian Muellauer.
- Norway , Oslo, Sunshine factoryand DNV with Etienne Gernez.
- France, Paris, HARADA Studio, Cesar Harada.
- Japan, Tokyo, FuRo with Nae Morita.
- Mexico, Ensenada, Amorphica collectice, Aaron Guiterrez, Julia Cerrud.
- Chile, Universidad de Austral Chile, Gonzalo Tampier.

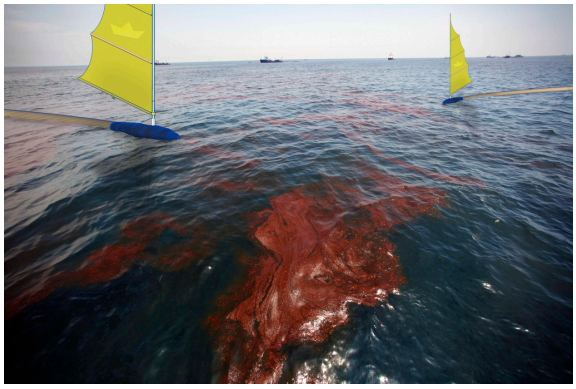
The first clear beneficial of this technology will be the environment upon which we are applying the technology. Any human being concerned with the environmental health of the ocean will benefit from Protei, especially coastal communities. The fact is we are all dependent with the health of the oceans as it does impact all aspects of our lives : the climate on earth, the air quality, the water we drink, that feeds our crops and animals, everything we eat. Without water it is unlikely there would be any life form on this planet and of the quality of water depends our future. We know it is going to be a long process but we expect our technology to be economically competitive and become a game changer in how we interact with the ocean when it comes to sensing or cleaning.

- Benefits : Technology applications scenarios
- Sensing : Oil, radioactivity, plastic debris, fish stocks, coral reefs, algae blooms, oceanography and natural reserve monitoring.
- Cleaning : Oil spill, plastic debris, algae blooms.

What impact has your technology had on the relevant problem in the field? Who and how many people have benefited, and how?

Please present evidence from credible sources to support the claimed impact. note that objective, methodologically rigorous assessments of impact will be given the most weight by the judges. If there are known or unintended or negative consequences, please address these by discussing how you have, or plan to, deal with these issues.

Oil spills (1. Sensing, 2. Cleaning)
In the first phase of development, small Protei units would be deployed for sensing oil, to detect leaks, locate plumes and help coordinate clean up efforts. In a second phase, a swarm of Protei larger units could be used to drag oil sorbent booms to absorb oil, bringing back oil-contaminated booms either back to shore or to a mothership where booms would be treated. Cleaning up oil spills is our ultimate technical goal, on the way to achieve this, easier tasks could be performed.
Current state : 700 repurposed fishing boats cleaning up the BP oil Spill exposing the health of cleaners, would not be able to operate at night, far from coast or in rough weather. Each vessel would have to be repurposed, 3 men would be working, plus the cost of fuel, insurance and maintenance.
Improvement with Protei : A fleet of Protei could operate night and day, far from shore, in rough weather without exposing the health of cleaner for a fraction of the cost at initial investment as well as cost per day for operations.

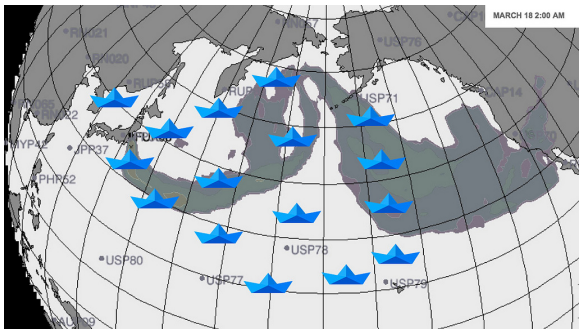


Simulation : A swarm of 6m Protei pulling long oil sorbents, cleaning oil spills.

Plastic Debris (1. Sensing, 2. Cleaning)
There is still a lot to understand about distribution and characterization of plastic debris in the ocean. We are only starting to uncover the complexity of the plastic gyre and designing process to collect and re-purpose the plastic collected. The envisioned scenario to clean up plastic is to unroll nets behind Protei tethered from a treatment platform. Sailing away and sailing back to the treatment platform, the long thin net would then be cranked into the platform where plastic debris would be separated and treated.
Current state : there is currently no efficient technique to collect large amounts of plastic debris form the ocean.
Improvement with Protei : We need an unmanned transport of fine nets to go over slow and very long repetitive plastic collecting patterns. The distances to cover are so great, wind power may be the only solution that makes sense. We are in Discussion with Kaisei [http://www.projectkaisei.org/] and similar interest group in Europe.

Simulation : A swarm of 6m Protei pulling long nets and collecting marine debris.

Radioactivity (Sensing)
Many contradictory reports have been published about radioactivity on land and at sea around Fukushima Nuclear plant. On land, the radioactivity measurements provided by the government and TEPCO (Energy company) were sometimes only half of what local residents measured. Far off-shore very few indicators are operating independently from the Government or TEPCO that assure there is "no measurable radioactivity" beyond the safety perimeter, again contradicted by truly independent measurements on the other side of the Pacific in California, even if the levels reported were "never a health risk". Having a fleet of independently operated Protei to navigate and measure radioactive plumes and hotspots on demand could really enhance the verifiability and accuracy of current radioactivity sensing.
Current state : A matrix of sensors is placed in the water in the 25km perimeter around the power plant. Sporadic measurements are made beyond the perimeter.
Improvement with Protei : Protei would enable dynamic measurements to be made and find “hotspots” as well as determine maximum and minimum points, edges of contaminated plumes etc.



Simulation : A swarm of 1m Protei Sensing radioactivity in the Pacific.

Fisheries (Sensing)
Fish swim around and it is not an easy task to count them with one boat over a large area. Fisheries scientist cannot "scan" large areas in one go and often their claims of declining fish stocks are contradicted with local fishermen who know exactly where to find the greatest concentration of fishes. Both opinions are based on incomplete information. Using a fleet of Protei, we could literally "scan" large bodies of water and asses fish stocks much more reliably.
Current state : Large expensive research vessels seldom go to count fish and provide measurements that are disputed by fishermen that want to keep fishing.
Improvement with Protei : having reliable information could end disputes and avoid collapse of fish stock and in some case extinction of species.

Algae Blooms (Sensing)
Algae blooms can be extremely large ephemeral harmful events. Satellite observations could be coupled with water samples and contribute to understand better how Algae blooms are happening. Protei unit could cary water samples.
Current state : Research vessels are sent on locations determined by satellite but they lack “ground” verification.
Improvement with Protei : We could understand algae blooms phenomena better if we could get situated environmental information with micro algae samples.

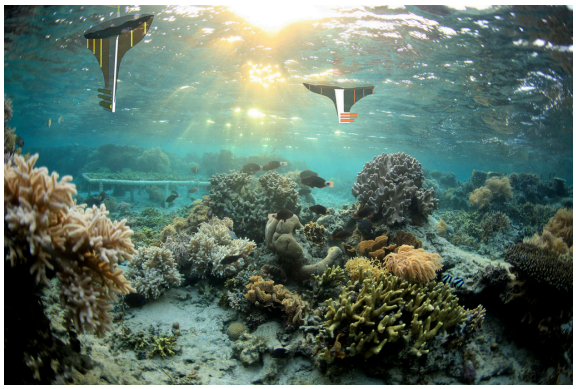
Coral Reefs (Sensing)
Natural reserves and coral reefs are often large areas that require a lot of care but usually administrations do not have a lot of money to work with. Having low cost, effective and non-invasive remote sensing instruments would radically improve how much science could be made. Small, unmanned, silent instruments would make sanctuaries full of timid animals accessible to observation.

General Oceanography (Sensing)
Currently most of physical oceanography measurements are provided by Argo drifters, robotic probes that dive for about 10 days, surfacing for a few hours. An array of about 3500 drifters are currently in operation providing data on conductivity, temperature, salinity, density, chlorophyll and backscattering. We could significantly improve surface data with constantly connected real-time environmental probes.

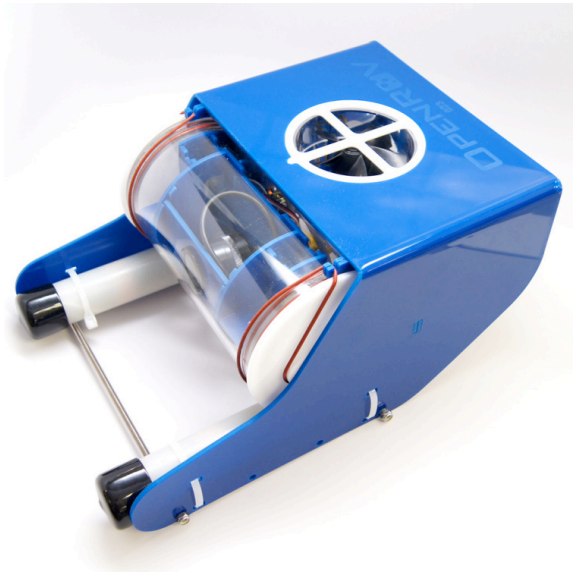
Coordination with underwater vehicles.
A surface craft could work in coordination with a sub-surface craft and provide it a satellite link and/or a mobile energy source. For example researchers at the SCRIPPS institute are using the Wave Glider to deliver data produced pushed by seismographs from the bottom of the ocean. Once dropped at the bottom of the ocean, the seismograph communicates to the surface wave glider using acoustics, the wave glider remains in a stationary position above the seismograph communicating to the satellite.

Simulation : A 6m Protei passing above a school of fishes.

Simulation : 6m Protei studying algae blooms.



Simulation : 6m Protei fleet monitoring a natural reserve and measuring the health of coral reefs.



One of our favorite project happening now is the OpenROV, an open source little submarine. Go 100m deep for about 750 USD [http://openrov.com]

Explanation of Leading Edge or Breakthrough Technology

Why do you think that your use of technology is worthy of recognition? Describe if it is a new technology or a new use of an existing technology. How can it be distinguished from existing uses? Explain how it surpasses previous or current solutions.

Worthy of recognition

We think Protei is a technology worthy of recognition because it addresses major environmental issues with an innovative and scalable Open Hardware technology using renewable energies.
The shape shifting hull introduces many new potential properties for sailing vessels.
Because the payload is not inside the hull of the vessel but dragged behind, the size of the payload can vary greatly, a very flexible platform for transporting research instruments, cleanup material or any form of cargo.

Recognizing Nature

Sailing boats exist since millennia and have been the instruments for the human colonization of all continents.
Fishes have been in existence long before humans, and most of or boat hulls have been inspired by their shapes, but not by the way they move. Protei propulsion does not come from the bending of the hull but from wind power; the shape of the boat controls the trajectory.
Our sails are inspired by flying animal wings such as bats, insects, birds. We hope that by combining the best of the flying (birds) and swimming animals (fishes) we will get a highly performing propulsion system to sense and clean up oceans.

New family in robotics, new investigations

As explained in the “technology innovation” section, Protei inaugurates several research questions in the realm of physics, electro-mechanics and Artificial Intelligence. The way Protei is developed as Open Hardware for the environment is also a singular choice, grounding itself in the new born culture and legal framework. Lastly Protei technology is developed with a new set of ethical priorities in mind, outlining a business strategy that is the counterpoint of “business as usual” (explained in more detail in the next part).

Acquired recognition

Although a very new technology that still needs to be backed by more solid theory, Protei successful prototypes have gained international recognition for its innovation, open-source design and pluripotentiality to various fields of oceanographic research, waste and pollutant mitigation.

_ **Medias** such as TED, CNN, Huffington Post, Wired, The Guardian, Vogue, Vice, Motherboard, Good.is, Fast Company, Innovation Daily, as well as specialized : New Scientist, nature.com, Physorg, Hackaday, Zeilen, Bateaux, Treehugger, and many others have featured Protei and the Open-H2O group.

_ Protei has also won several **prizes**, the prestigious ARS Electronica “Hybrid Art” Honorary Mention (2012), as well as the VIDA Awards for Artifiicial Intelligence and bio-mimicry, Fundacion Telefonia, Spain.

Protei has been featured in numerous **exhibitions** around the world since its early days, receiving feedbacks and suggestions from thousands of visitors : CIGAC, Rio de Janeiro (BR). Eyebeam, New York (USA), Open Hardware Summit 2011 (USA). DEAF, Dutch Electronic Art Festival Rotterdam (NL). Cultura Digital Brasil, Rio De Janeiro (Brasil), Tracing Mobility, Haus Der Kultur Der Welt, Berlin (Germany), Surface Tension: The Future of Water, The Science Gallery Dublin (Ireland), Strata Mini Maker Faire in New York, NY (USA). Maker Faire, in Flushing, NY (USA). Network fabrication, Ensenada (Mexico). V2_ Summer Sessions Rotterdam (NL). Protei with Oil Compass at the ISEA 2011, Istanbul (Turkey). Weather Tunnel, International Triennial of Media Art, Museum of Contemporary Art, Beijing (China). Wereld van Witte de With Festival in Rotterdam (NL). Datapolis, Prag (Czeck Republic). Tokyo Midtown DESIGN TOUCH 2010 (Japan). INDAF "Blur", Incheon, Seoul, (Korea)...

Protei has been building strong **academic partnerships** with renowned Universities like Stanford (San Francisco, USA), MIT (Cambridge, USA), ITP (New York, USA) T/u Eindhoven (NL), Syddansk University (DK), Hongik University (Seoul, KR), Goldsmiths University of London (UK), Southampton University (UK)...

The leader of Protei, Cesar Harada became a **Senior TED Fellow** as he was developing Protei in New Orleans and presented Protei around the world in numerous TEDx events in English, French, Spanish and Japanese.

Thousands of people have recognized Protei as a promising technology. The Open-H2O community continues to grow organically on social media as the group activity becomes more and more structured. The community is counting the days until Protei will start to sense and clean up the oceans.

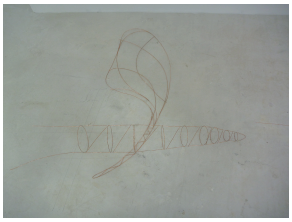
Evidence of contribution

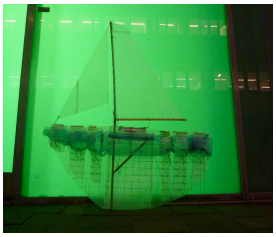
How do you know that your application of technology is making a contribution?

Protei has not cleaned up an oil spill yet, the technology is currently under development. Protei like many other technologies is going through stages. From observation, sparks the creative intuition, followed by the fabrication of prototypes, experiments to see it working in practice, as we try to understand how the theory of this object could be formulated, new properties are discovered, as we try to predict how this would scale up and if a general rule could possibly emerge from the many experiments we are setting. The way Protei develops is rooted in the tradition of empirical innovation, adapting experimental physics protocols to the contemporary DIY culture and citizen science movements.

We think by prototype. We fail often, we make many mistakes, we try everything. And that is why we make so many iterations, that is how we learn so much and eventually make some successful experiments. Our prototypes are the evidences of our contribution. Soon we'll make products to put in the hands of our community, and it is our broader community that will accelerate exponentially the development of Protei's technology and many other open technologies to serve the oceans.





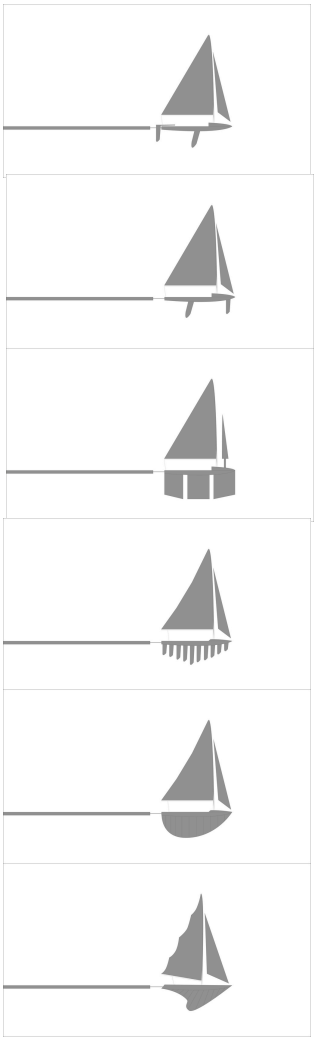

Building, testing and sharing versions

- 001: 2010/08/12. 92cm long. New Orleans USA.
- 002 : 2010/08/16. 99cm long. New Orleans USA.
- 003 : 2010/08/21. 400cm long. New Orleans USA.
- 004 : 2010/09/01. 450cm long. Incheon Korea.
- 005 : 2010/09/12. 50cm long. Seoul Korea.
- 005.1 : 2011/03/29. 102cm long. Rotterdam NL.
- 005.5 : 2011/06. 125cm long. Rotterdam NL
- 006 : 2011/09. 300cm long. Rotterdam NL.
- 007: 2011/12/22. 150cm long. New York, USA.
- 008: 2012/02/01. 85cm long. London UK.
- 009: 2012/05. Eindoven NL.
- 010 : 2012/09 expected. San Francisco, USA.

The advantages of a shape-shifting hull

Many have asked this legitimate question "Why not using a conventional sailing boat to pull something?" and "How will this fancy shape-shifting robot contribute to the betterment of the situation in the oceans?". The answer is that a shape shifting hull enables to pull a lot more payload than a conventional sailboat. Protei remains more stable, maneuverable at both low and high speed while pulling something long and heavy. It is an optimized propulsion system that is inspired from the outstanding performances of fishes swimming in water and birds flying in the air, stabilized by a long tail.

Accelerated Evolution of sailing
What we are doing at Protei is an accelerated evolution of the science of sailing. Version after version the technology improves, simplifies, becomes more elegant and robust. It also gets easier to build, cheaper and we're using better materials.



Protei is a unique marriage of current advances in artificial intelligence, maritime engineering, traditional sailing aerodynamics and revolutionary design. It lies at the intersection of art and science, design and utility – an aquatic chimera that will change how we do oil spill collection, radiation monitoring and general oceanographic data collection. It is not proprietary, but freely accessible. It is state of the art, but comparatively inexpensive and developed ethically.

Presentation of Measurable Results

Describe the method(s) you are using to measure your results. How are you reporting your results and to whom? To whom are you accountable?

We have many criteria to evaluate our performances and a matrix of desired properties that we use as engineering targets for Protei. But we have first criteria as an organization. Protei and Open-H2O order of priorities determines how we will evaluate success :

Environment : how much of a positive impact we have on the environment? We can count this in tons of oil or plastic we collect. We can count the amount of significant environmental information we collect.
Social : how healthy and happy is our crew, the people we work with, for, and all other earthlings?
Technological : how purposeful, efficient and promising is our technology? We can see how many people use our technology and how it serves our greater purpose.
Profit : how much capacity of action can we externalize using money to maximize a positive environmental impact?

Technically and specifically about Protei technology, we have different things we measure / evaluate :

- Environmental impact and efficiency
- Safety and limitation of potential hazards.
- Unsinkable
- Self-righting, healing moment
- Self-powered and steered
- Maneuverability, Stability in maneuver
- Speed at different points of sail, different wave and current conditions
- Radius of tacking and jibing
- Bollard Pull (pulling power)
- Environmental noise reduction
- Resistance, Turbulence, flow analysis (Velocity Prediction Program)
- Material resistance to corrosion, fouling and mechanical stress.
- Cost
- Ease of replicability, manufacturing ease, distribution, regulations, taxes, insurability
- Usage of Open Source / Hardware standards, quality of documentation, interoperability

Roadmap of measurable results
September 2012 : 1m Remote controlled Protei as Prototype.
We can already make environmental measurements at this stage.

- December 2012 : 1m Remote controlled Protei as beta Product.
- June 2013 : 6m Manned Protei prototype.
- June 2014 : 6m Manned Protei beta Product.
- October 2014 : 6m Autonomous prototype
- We can start clean-up plastics and oil at this stage.
- October 2015 : 6m Autonomous product

Reporting and accountability milestones.
More than any other project we publish constantly, even immature or incomplete current research because this is part of our process : we strive on criticism and feedback from our community. This way our research is constantly peer-reviewed (as it is peer generated!), we often make short publications, our drafts are accessible online as we write them.
Of course we need money to operate so beyond being accountable to the environment, we are also accountable to those who invest financially in the project. The sources of funding for Protei have been changing and we expect them to evolve this way :

- 2010 - 2011 : crowd-funded : 300+ individuals and organization have "backed" us on Kickstarter (thank you!!!)
- 2011 - 2012 : philanthropy : supporters
- 2012 - 2013 : sponsorship : Sponsors, Media Exposure
- 2013 - 2014 : grants : Scientific partners
- 2014 - 2015 : Sales : our customers
- 2015 - 2016 : Operations. Data collection and clean-up : local residents, companies, non governmental,

Description of Potential Negative or Unintended Consequences, mitigations.

Describe any outcomes that may not be beneficial that you have considered. Who might consider your application problematic and why?

Because Protei is developed Open Hardware and no constraining licensing exist to restrict the use or transformation of the technology, it opens way to fast technological progress and a diversification of the technology application, and also of the misuses that can be made of Protei technology. The best we can do is to encourage best practice and use of our technology.

Military use

With its silent, near invisible radar signature, long range and large payload capacity Protei would be a very attractive platform for military uses when it comes to transport cargo, combustible, fighting material and espionage.

At Protei, we have decided not to sell, help or provide customer support for any military related matters unless it takes place in humanitarian or crisis relief situation.

Swedish Army stealth boat.

Illegal Drug Trade

There is a whole class of submarine designed to transport drugs called “narco-sub”. Ultimately Protei would be a very economic and efficient way of transporting drugs over long distance. Now being a sailboat it would easily be spotted on the horizon, and its low speed would not make it the best strategic transport for illegal highly-valuables.

Narcosub being intercepted.

Traffic accident

The most realistic concern about autonomous sailing robots is maritime traffic accident. The hull of Protei being flexible poses no threat to other vessels in the event of an impact, Protei would just bend. The worst case scenario would involve the payload of Protei getting stuck into a larger vessel propeller. A simple way of avoiding this is to have on each Protei a data connection that updates the position of Protei on http://www.marinetraffic.com. The AI of Protei accesses this database periodically to know where other large ships are in order to avoid their routes but also because we are working on algorithms to predict where the next oil spill / chemical spill at sea is most likely to happen based on the density of ships transporting oil and other chemicals.

Fishing

As much as we intend to use Protei to assess fish stocks and implement best fishing policy, having a cheap wind powered vessel that can tow a large heavy object, indicates Protei could be used to help illegal fishermen locate fishes and practice destructive fishing techniques such as bottom trawling.

Waste

Lastly, there is always the hazard of loosing a Protei unit at sea that would become a waste adrift. The main environmental hazard of Protei would be its electrical batteries. Protei large units would all be equipped with satellite emergency notification device like any deep-sea going vessels. A separate electric system would guarantee a safe and constant activation of the emergency system so on-shore Protei human operators would be ready to rescue adrift Protei if needed. At the end of life of Protei, we will assist Protei owners that an efficient recycling procedure does not transform Protei into an environmental threat.

Scaling and Replication Potential

What is the potential for this technology to be used to serve more people? If you have plans to scale up, please discuss them. Could your work be a model for others to emulate, and/or could this technology be put to use in other places or contexts?

Current situation : Lack of collaboration and interoperability to solve large problems

The problems the oceans are facing are colossal. Most harm to the oceans is man-made which gives us equally good reasons to think our efforts could lead to fix these problems. Humans have created technologies that have damaged the ocean, it is time to revert that trend and work together to fix these issues.

Many groups such as large corporations, governments, non-governmental organizations, universities, activists groups and single individuals are pushing forward great initiatives to understand and clean up the oceans but many barriers remain.

We believe the first obstacle to greater understanding and cleaning of our oceans is the lack of international coordination and collaboration, which may be due to the complexity and diversity of development methods and formats. It would be a bad idea to try to harmonize development methods because it is from this variety that innovation emerges and allows sane competition. What we can do in the immediate future is create an effective collaboration platform and determine common evaluation criteria to foster efforts - being more objective driven than method driven.

The second obstacle are intellectual property barriers. Historically Intellectual property have been created to promote the development of technology by protect the interests of inventors and industries. Later, intellectual property became security means for states and instrument of control and monopoly guarantees for large corporations. Patent trolls have started to slow down innovation and many nascent businesses have identified traditional intellectual property as a hinderance to propagate new technologies. It is in this context that the techno-social Open Source movement took over in our information age. The similar thing is now happening in the hardware world and we believe is going to be a major factor in the next manufacturing revolution and social model for collaboration.

Open-Hardware

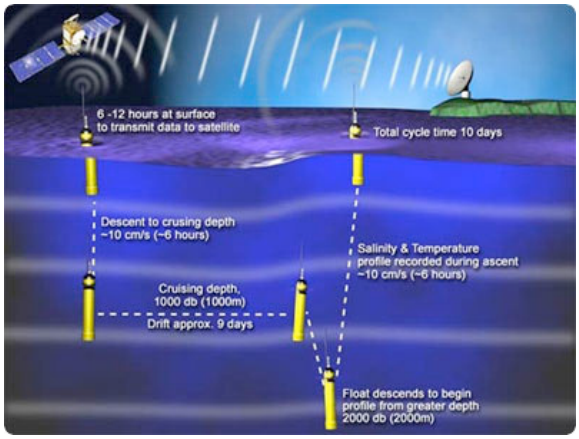
Open Hardware means that everyone is free to use, modify and distribute (as in manufacturing and selling) the technology for free. The only 2 required conditions are that the creators of the original technology should be credited appropriately and that any improvement made to the technology must be shared back with the community.

Many may find this counter-intuitive and wonder where the profit will come from for the inventor and the manufacturer. Many successful companies have now proven the case of Open Hardware as a very profitable foundation for a business and the market is now exploding on both demand and offer.

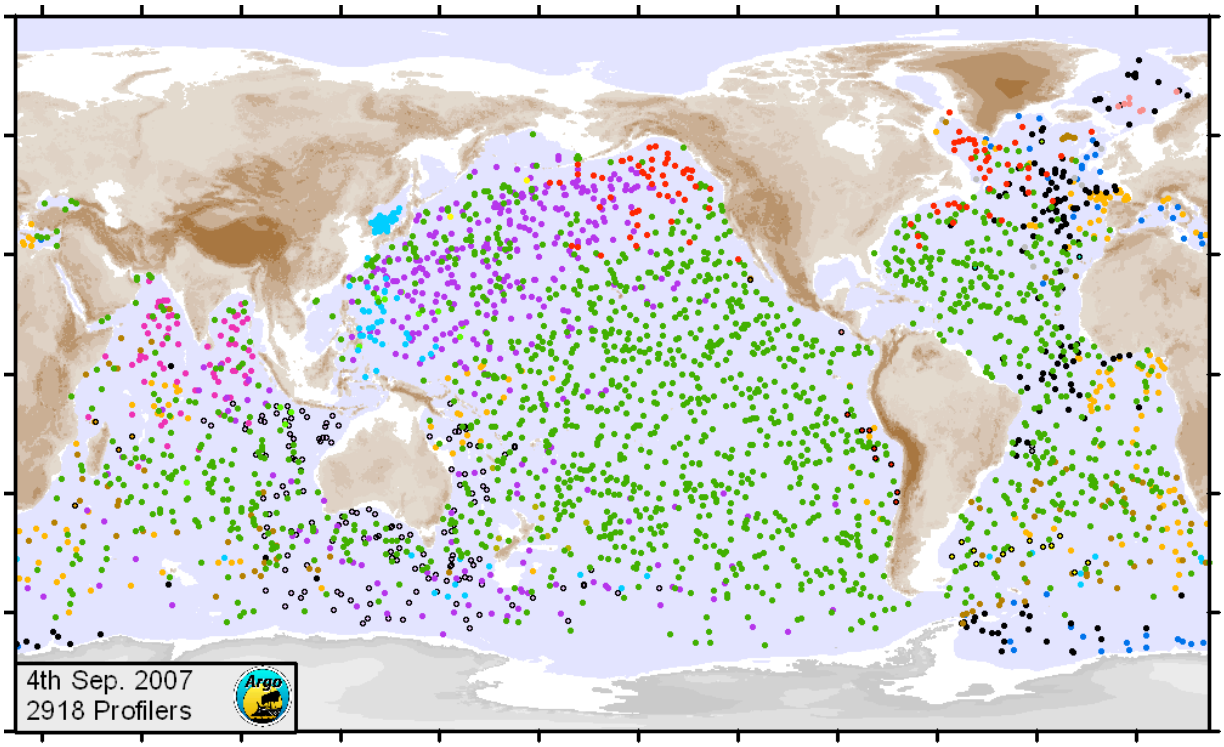
Cesar Harada co-signed the first release of the Open Hardware license in 2010 at the Open Hardware Summit. In 2011 Protei was presented at the Open Hardware Summit as the spearhead of Open Hardware for the environment, inspiring many new projects.

Development model : ARGO

Open Hardware legally enables large corporations, governments, non-governmental organizations, universities, activists groups and single individuals to innovate together efficiently while being confident their technology will remain accessible to the greatest number. In oceanography a striking evidence of a similar success is the ARGO drifter fleet. With about 3500 drifters provided by more than 30 different countries, the fleet provides the most reliable near-real time source of information to understand climate change and many other global dynamics.Long before Open Hardware, scientists from all over the world shared their knowledge and experiences and It took about 30 years to develop this amazing sensor array. We believe that we will deploy a much more pervasive technology in much less time and money with Open Hardware, general high-speed connectivity and the pressing environmental challenges we are facing.



Argo Float cycle



Argo Float in 2008, about 2918 profilers. Today in 2012 Argo is comprised of more than 3500 profilers. The development and deployment of Argo is very inspirational for Protei and gives us a good idea of the array necessary to study oceans and the international market capacity.

Transparency and Cost

Open hardware also guarantees that the technology will always remain as cheap as it can possibly be. One of the most important requirement of Open hardware is to provide a part list of the components of your technology. This means at some point someone will replicate a technology at a better cost. This means the technology will improve fast and that the price will go down fast too. This is a criteria of dramatic importance :

taking the example of oil spills. Oil spills are not only happening in the Gulf of Mexico or in the waters of rich countries. In fact most oil spills took places in remote areas when little to no money nor technology was available to remediate oil spills. Making an efficient, affordable Open Hardware technology would totally change the equation.

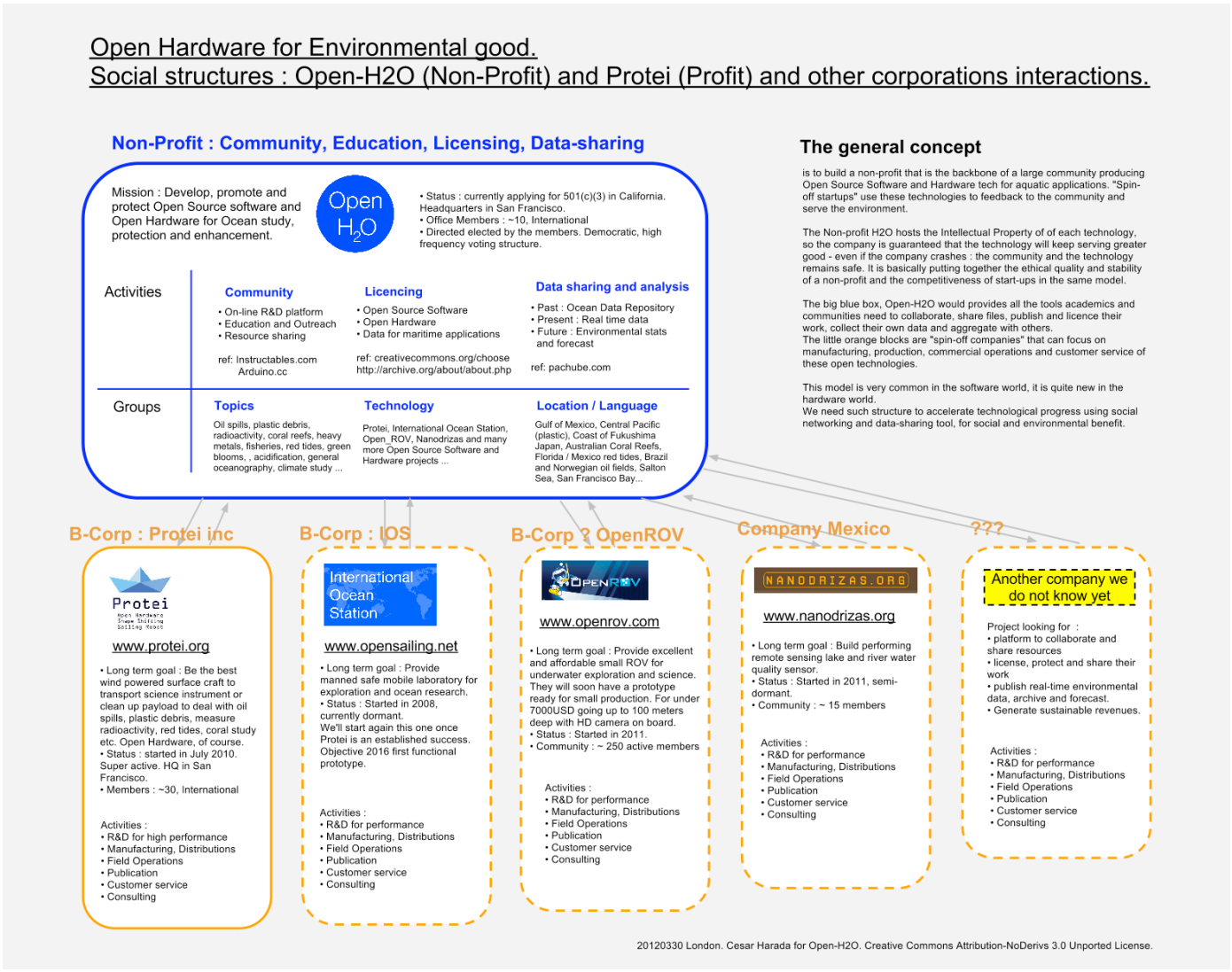
The same goes for coral reef protection often located in tropical waters.

Open H2O

Open-H2O is the community, the people that develop open technologies for the ocean. It is a non-profit.

Protei
Open Hardware
Shape Shifting
Sailing Robot

Protei is a technology developed by Open-H2O community. Protei inc. is a spin-off startup that manufactures, sells and operates Protei. It is a B-Corp.



Open-H2O community (Non Profit) & Protei Start-up (B Corp)
The Open-H2O community (Non Profit) develops and licenses Protei and several other Open Source softwares and Open Hardware technologies for the ocean. Protei technology is used, modified, manufactured and distributed by Protei Inc (B Corp), a spin-off technology start-up. This way we can guarantee both the ethical integrity of how the technology is developed with the non-profit, as well as being commercially competitive with our start-up : making the best of both worlds. Both the non-profit are based in the Bay Area but operate internationally. The non-profit and start up are separate entities with different directors and administrations - some members are in both organizations. Rather than setting up heavy static social structures, Protei uses a network of innovators and will continue to be a flexible lean organisation with blurry boudaries to always connect the most exciting emerging creative to the most established experts.

Decentralized R&D, manufacturing and operations.
Similarly as R&D is done in many places simultaneously, the manufacturing of Protei too is decentralized. Protei as well as being an Open Source technology is also an appropriate technology, which means that the technology is appropriated, adapted to local applications as well as local fabrication methods and materials. This is to ensure that no central monopoly is established, but also reduces environmental footprint using local material. Decentralized manufacturing means that customer support is also available locally creating a sustainable local economic benefit for our globally developed technology. Protei development is characterized by rapid prototyping, aggressive testing and the use of social media to get frequent feedback on our technology.
We are confident that the rise of awareness about ocean issues, the internet of thing, the Open Hardware Movement, citizen science groups and the rising popularity of personal fabrication with desktop 3d printers will power the fast growth of our technology.

Re-use
The core of Protei is a modular technology that can be easily maintained, upgraded and re-used for other purposes. We envision durable products with long life spans and being used for a variety of applications.

Short Description of Technology

Describe your technology in 75 words as you would like it to appear on our website.

Protei is an unmanned shape-shifting sailing robot developed Open Hardware by a global community of makers.

Protei has no rudder nor centerboard : the entire hull bends to control this sailing robots providing it unprecedented sailing properties.

Originally developed to clean up oil spill, Protei will be used to measure radioactivity, plastic debris, monitor fisheries, coral reefs, algae blooms, provide general oceanographic data or serving as surface satellite link to underwater vehicles.

Recognition of Contribution

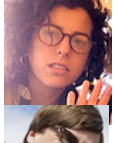
Does this work draw upon the intellectual property or substantive contributions of others who should be acknowledged and appropriately referenced?

Protei is being developed by an international team. The design are licensed under Open Hardware, the documentation under creative Commons. code under GPL, name “Protei” is a US registered trademark. Credits “Protei team” :

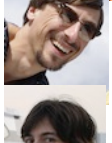
_ Cesar Harada (FR, JP, UK) Inventor of the Protei system, Protei Principal Investigator.
PhD Candidate in Design at Goldmisths University of London. Tutor for Master in Design & Environment at Goldsmiths University. TED Senior Fellow. MA Royal College of Arts London, MA Animation Film ENSAD Paris. Former Project leader at MIT Senseable city lab on the Seaswarm Project. Former resident prototype maker at Southampton University, Fluid Mechanics Laboratory. Instructor for aerial monitoring the Oil Spill in the Gulf of Mexico USA with the Louisiana Bucket Brigade and the Public Laboratory. Independent study of radiation in Fukushima Japan with the support of Greenpeace Japan and Safecast. “White card” member of the Ushahidi *IHub_ Mobile technology Incubator in Nairobi Kenya. Recipient of the ARS Electronica Golden Nica [NEXT IDEA] 2009.

_ Etienne Gernez (FR, NO): Protei Academic coordinator.
Maritime Engineer, DNV (Det Norsk Veritas) Oslo Norway. Working at the Ships Hydrodynamics and Stability unit (NTANO362). He is a graduate from the University of Southampton (UK), the University of Bordeaux (France) and the University Centre of the Westfjords (Iceland) in Numerical modeling, Maritime Engineering Sciences, and Coastal and Marine Resources Management.

_ Peter Keen (New Zealand, UK): Maritime Engineering and Operations.
Maritime engineer specialized in instrumentation and operations. Southampton University, UK.



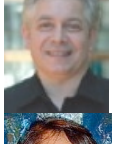
_ Gabriella Levine (USA) : Maker, Hacker
Interactive artist and open-source hardware designer. (USA), Interactive Media, ITP NYU.



_ Sebastian Muellauer (Germany): Product Designer
Studied Industrial Design at Burg Giebichenstein in Halle (DE), and at the Design Academy in Eindhoven (NL).

_ Piem Wirtz (NL): Product Designer & Project Manager
Project manager at the V2_ Institute for the Unstable Media, MSc Industrial Design Engineering from TU Delft, NL.

_ Kasia Molga (Poland, UK): Data Visualization and Interactive Artist



_Dr Zenon Chazko (Poland, Australia) : Biomimetic computational models, software design, wireless sensor actuator networks (WSAN). Senior Lecturer of Software Engineering at University Technology Sidney and Program Head of Information and Communications Technologies.
25 years of experience in marine systems in the engineering industry (Krupp/Thiessen, Thales, Boeing/Raytheon).

_ Alvaro Takiuti (BR, JP, NL): Maritime Engineer.
Graduated from the University of São Paulo - Brazil. Class Society Surveyor. FPSO/FLNG Regulatory compliance Engineer at SBM.

_ Fiona Crabbie (UK, Sweden, Norway): Naval Architect, specialised in Superyachts
_Qiuyang Zhou (China, Denmark) : mechatronics, University of South Denmark.
_ Roberto Melendez (El Salvador, USA) : Ocean Engineering MIT
_ Logan P Williams (USA) : Electrical Engineering MIT.
_ Ru Mahoney (USA): Non-profit management and Education outreach
_Gonzalo Tampier (Chile) Naval Architect, University of South Chile
_ Maia Marinelli (Italy, Hawaii): Professional Sailor and Artist
_ Aurelie Vincent (FR): Communication, strategy, fund-raising
_ Shah Selbe (USA) : Systems Architect, FishNET project at Center for Ocean Solutions, Stanford University. Illegal Fishing Mitigation Technology. Engineering within the Developing World
_ Toni Nottebohm (Germany) FIlm maker, University of Munich, Germanny.
_ Hunter Daniel (USA) Photographer, New Orleans (USA).
_ Earl Scionneaux (USA) Composer, Sound Engineer
...
All Protei members are on https://sites.google.com/a/opensailing.net/protei/people

Designation of Use of Prize Winnings

The purpose of awarding the $75,000 or $25,000 cash prize to Laureates in each category is to contribute to solutions to the urgent challenges being addressed by The Tech Awards Laureates. To that end, we ask you to briefly describe below how the cash prize will be used if you are selected to receive it. To promote the values of The Tech Awards program and sustain a high level of credibility for your work and the Awards program, The Tech will require that highly-funded Laureates designate another entity as the recipient of the actual cash. If you are selected as a cash prize winner, describe how you will use the funds or if applicable, designate another recipient.

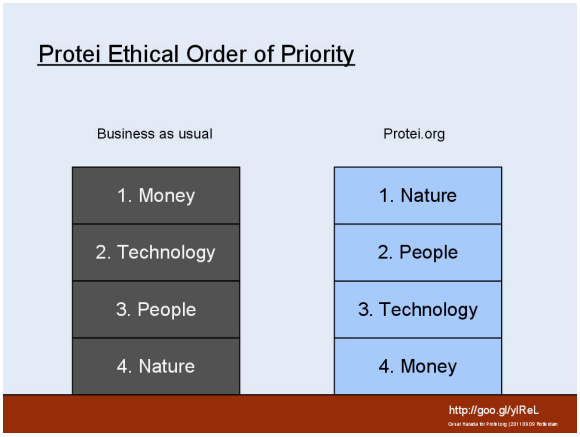
The purpose of awarding the $75,000 or $25,000 cash prize to Laureates in each category is to contribute to solutions to the urgent challenges being addressed by The Tech Awards Laureates. To that end, we ask you to briefly describe below how the cash prize will be used if you are selected to receive it. To promote the values of The Tech Awards program and sustain a high level of credibility for your work and the Awards program, The Tech will require that highly-funded Laureates designate another entity as the recipient of the actual cash. If you are selected as a cash prize winner, describe how you will use the funds or if applicable, designate another recipient.

Definition of Large Well-funded
For profit Company = Annual revenue equal to or greater than $1B for most recent fiscal year.
Non-profit Organization = Annual budget for the organization equal to or greater than $1B for the most recent approved budget year.
University = Annual budget for the specific project equal to or greater than $50M for the most recent approved budget year. Clarification required confirming that the cash prize will be given to the specific project.
Government Organization = Annual budget for the specific project equal to or greater than $50M for the most recent approved budget year. If the government agency is extremely large, for example UNICEF or UNDP, a specific clarification is required by the organization to ensure that the cash prize will be used on the specific project that is being awarded. If the award money is given to a 'general fund' then a designation to an outside organization is required.
Individual = If personal net worth is greater than $25M and this number can be verified using public means then the individual will be asked to designate a recipient for their cash award.

Protei needs to maintain funding to continue technology development, foster continued collaboration, and support dissemination of the technology. These activities necessitate project infrastructure for collaboration, travel to conduct research and development of Protei design, as well as prototype testing and the ability to effectively network with industry and research leaders to engage environmental stakeholders in exploring the capacity of open-source technology to address environmental challenges. Protei is currently applying for non-profit status in the US and UK.

Ethics of a business
To heal the oceans and work efficiently together towards intelligent green technologies, we must change the current order of priorities and how business as usual operates.
Through partnerships with universities like Stanford, Goldsmiths and MIT we have been able to engage every level of participant between undergraduates, professors, industry professionals, non-profits and individuals.

We have an urgent need to develop long terms ways to sense and clean our vast oceans. Current technologies are either passive and affordable but ineffective, or extremely expensive, manned and depending of fossil fuels and dangerous.
We need active solutions that are affordable, unmanned and running on renewable energies for extended periods. Saying that environment will always be able to tolerate human environmental crimes is a deliberate lie. Most of human-made problems can remediated by human efforts, and these efforts must be coordinated with precise ethical objectives as well as business practices.
Next page is a proposed budget.



Item	Cost USD	Subtotal
Documentation Publication / Print / presentation material	250	
Event	500	
Exhibitions / Fairs	400	
Goodies / uniforms	200	
Total Communication		1350
B corp status	350	
Competitions applications / grants app	200	
Insurances	200	
Non Profit status	500	
Patent Pending	350	
Visas and other legal matters	2000	
Business advising	200	
Total Legal / Admin		3800
Manufacturing_Subcontracting	17000	
Manufacturing_Distribution	2000	
Manufacturing_Taxes	1500	
Manufacturing_Transport & Export Taxes	3000	
Rewards for Kickstater backers	1000	
Total Manufacturing		24500
Academic support / Education mini-competitions	500	
Work fees, 2 staff, 4 months	10000	
Total Personal fee		10500
Prototyping_ Workshop rental monthly	800	
Prototyping_Materials	3000	
Prototyping_Testing	100	
Prototyping_Tools	1000	
Research_Electronics	1500	
Research_Experiment Physics	500	
Research_trip	200	
Research_ Artificial Intelligence	300	
Total Prototyping & Research		7400
Online advertising	50	
Real-time database & mashup	200	
Social Media viral com	0	
Software licences	50	
Web_Development	800	
Web_Open Hardware licence	1000	
Web_services	100	
Web_Shop	250	
Total Community Web Development		2450
GRAND TOTAL	50000	50000

References

Please provide three (3) references who will verify the effectiveness and impact of your work. Good references are professionals from outside your organization that have a working knowledge of your technology, and the operations of your organization. Do not use relatives or other individuals within your organization as references. Provide your references' contact information below. You must provide valid email addresses for your references

Reference 1 : Hajime Narukawa

Director of AuthaGraph CO., Ltd.
Tutor, Kuwasawa Institute, Tokyo
Tutor, Tokyo Zokei University, Tokyo
Member of Japan Cartographers Association
M Fine Art Tokyo National University of Fine Art
M Arch the Berlage institute, Amsterdam

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Reference 2 : Andrea Grover

Andrea Grover is a migrant curator, artist, and writer. She has an MFA from the School of the Art Institute of Chicago, a BFA from Syracuse University and was a Core Fellow in residence at the Museum of Fine Arts, Houston. In 1998, she founded Aurora Picture Show, a now recognized center for filmic art, that began in Grover's living room as "the world's most public home theater."

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Reference 3 : Jun Kamei

Co-Founder of TEDxTohoku (Sendai, Japan. Area deeply affected by Earthquake, Tsunami, Radiation since March 2011).From Osaka prefecture. Department of Engineering, Tohoku University.

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Reference 1 : Hajime Narukawa

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Tokyo, 2012, May

Re: Mr. Cesar Minoru Harada

To whom it may concern,

It is pleasure to write a reference for Mr. Cesar Minoru Harada. I met him at TEDx SEEDS 2011 in Yokohama, Japan. To the audiences he gave a wonderful presentation about his idea of Protei for solving problems and collecting data on ocean.

I have developed a new projection method. And with it I made a rectangular world map which can equally represent any region including polar region with the least distortion. Now I have been making many thematic maps by using the world map to visualize data of the theme with this representation method of the world. One thing I found is that global environment is greatly influenced by complex mechanism of ocean but it is difficult to collect data. The reason why it is difficult is that the size of the whole ocean is too large. And then each institution in each country researches by its own method. Each institution develops its own high tech device by its own budget. To solve the problems they need to build up closer teamwork, to standardize the method and/or device to collect data. And then they need to develop cheaper device so that they can obtain enough numbers of devices to cover large area of ocean.

During Cesar's lecture in TEDx Seeds, I found that when his Protei is in wide use, it may clear the difficulties above. As far as I understand from his lecture, Protei highly simplifies the hardware therefore we can obtain it with limited budget or we can build it by ourselves since it is an open source. Since it is an open source anyone from various field can share the technology. Therefore Protei has a potential to be a standard hardware in Ocean Science and maritime. I can say Mr. Harada invented not only an outstanding hardware with "High-grade hardware with highly simplified technology" but also invented a new way to run this project to practice a technology. Thus I found he has outstanding talent not only in invention and engineering but also in leadership for practicing an idea.

Now we all Japanese are anxious for Fukushima radiation spread over the Pacific Ocean. Mr. Harada is now trying to collect data on site by Protei. He actually visited Fukushima right after the TEDx Seeds 2012 ended. I am impressed by his passion and quick action. I strongly hope he is able to collect data of the radioactivity. I am more than happy to plot data on the AuthaGraph map when he succeeds collecting it.

I strongly recommend Mr. Harada and Protei team as a candidate for the Tech Awards without hesitation, and hope that you will be able to accept him. I'll be happy to answer questions you may have about Mr. Cesar Minoru Harada.

Sincerely yours,

Hajime Narukawa
Director of AuthaGraph CO., Ltd.
Tutor, Kuwasawa Institute, Tokyo
Tutor, Tokyo Zokei University, Tokyo
Member of Japan Cartographers Association
M Fine Art Tokyo National University of Fine Art
M Arch the Berlage institute, Amsterdam

Reference 2 : Andrea Grover

From Andrea Grover
To The Tech Awards Committee:

This letter is in unequivocal support of Cesar Harada's nomination as a Tech Award Laureate.

I have known Cesar Harada since January 2009. I first discovered his project Open_Sailing on The Seasteading Institute's website. I was researching artists' projects that propose radical solutions to the distribution of food, shelter, transportation and energy to an anticipated world population of 9 billion by 2050. Open_Sailing was, by far, the most elegantly articulated and visionary project that I encountered, and it became the cornerstone of the exhibition, *29 Chains to the Moon*, which I curated for Carnegie Mellon University's Miller Gallery in October 2009.

When I first met Cesar, I realized at once that he was an extraordinary individual, whose belief in creating a better world went far beyond speculation. At just 24, he was actively engaged in assembling an international Open_Sailing team, building prototypes, and gaining access to specialized research environments. His enthusiasm for living at sea was contagious. He envisioned an entirely new paradigm for marine architecture, one that was in synergy with the surrounding environment, and mimicked the behavior of marine life. Cesar very wisely incorporated a global network of artists, designers, programmers, and engineers to assist with the creation of this "open_architecture" (open source architectural design). His marine engineering research has expanded dramatically in the last three years, and applied to an immediate and critical issue: oil spill remediation.

Along the way, Cesar conducted wave dynamics studies at Southampton Hydrodynamics Laboratory, and lead a team of scientists addressing oil clean-up technologies at MIT SENSEable City Lab. In order to conduct field research, he relocated to the Gulf Coast in Louisiana shortly after the Deepwater Horizon oil spill, and began work on his remarkable inflatable, robotic oil skimmer, Protei.

Protei is nothing short of a green revolutionary technology. It sails upwind, steers from the front, its hull is articulated for better steering control, its affordable, powerful, lightweight and safer than manned clean-up vessels. Protei can work day or night, as a fleet for even greater efficiency. The technologies for Protei are developed under Open Hardware, making the project available to be adapted for potential applications far beyond oil spill clean-up.

I have rarely encountered an individual who is so adaptive and responsive, and one who can work fluidly and conversantly across disciplines. Clearly, I am not alone in noting this quality in Cesar, as evidenced by his awards from Ars Electronica Golden Nica, ARS Electronica, and appointment as a TED Senior Fellow.

Cesar's international upbringing (having a Japanese father, the well-known sculptor Tetsuo Harada, and a French mother), and his fluency in four languages also contribute to the way he views the world as one continuous system. His collaborators are worldwide. His educational background includes the study of art, music, animation, martial arts, industrial design, new media, coupled with a passion for technology and the Oceans. At only 27 years of age, he has presented his ideas to artists and scientists alike at MIT Media Lab, The Barbican, Royal College of Art, Carnegie Mellon University, CCCB Barcelona, V2_ Institute for the Unstable Media Rotterdam, Future Craft, Nabi center Seoul, Strathmore University Nairobi, Ars Electronica Austria, the TED Conference, TEDxOilSpill, and so on.

Cesar Harada is contributing to resolving a global environmental issue, with technology that can be applied to a variety of marine pollution issues. As long as I've known him, he has made improving the quality of life for humanity his life work. It is my heartfelt belief that Cesar is exceptionally deserving of the Tech Awards.

Sincerely,

Andrea Grover
Curator of Programs
Parrish Art Museum

Reference 3 : Jun Kamei

Sendai, Tohoku, Japan 2012/05/24

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Letter of support for Protei

It is my pleasure to recommend Protei, a game-changing technology for Ocean Sciences lead by Cesar Harada, for the Tech Award nomination.

As a local leader in the northern part of Japan involved in relief works after the Tsunami disaster in March 11th 2011, I have the privilege to work with Cesar for more than a year on the potential use of Protei drone for the measurement of radioactivity in the Fukushima bay.

The innovation brought by Protei has always been lead by Cesar' s careful observation of the field site where the technology would be applied.
Concerned with the situation in Fukushima, Cesar has visited his native country performing a detailed radioactivity measurements on land and on sea between Tokyo and Sendai city, as well as gathering evidences from the local fishermen and inhabitants.
Not only the shape-shifting hull of Protei would allow a full maneuverability in disaster zone, I believe that the use of Protei as a drone for scanning radioactivity and collecting debris respond to local needs in time of such disaster.

As a whole, I would summarize the potential of Protei as below.
1. The scalability of the technology, application ranging from the oil spill and debris cleaning, to ocean studies including radioactivity.
2. The open hardware system, which allows the participation of engineers and designers worldwide.

I recommend Protei without reservation and am confident this innovation would provide new possibilities in the fields of Ocean Sciences and robotics.

Please let me know if there is need for further information from my part about this wonderful project Protei, lead by Cesar Harada.

Sincerely,

Jun Kamei