creation. Through the use of live conferencing, design thinking and ideation, solutions to challenges are being discovered and DuPont's innovation pipeline is flowing.

Three determinants characterise the modus operandi of innovation hubs, they:

- act as a catalyst for driving organisational change
- create the basis for a multiplication factor for growth
- become an instrument for attracting capital investment

In addition, there is a direct correlation between development of a hub and the increase in the level of learning development. Such activities lead to instilling a high performing culture that strengthens the organisation's readiness to innovation and builds its knowledge base.

Organisations which create innovation hubs have the ability to mobilise innovation initiatives quickly and can optimise the time taken to create new value for their end users and themselves.

HUBS LEADERSHIP & GOVERNANCE

Hubs provide an effective vehicle for shaping the dynamics of go-to-market solutions. Their primary focus on innovation make the measurement of their tangible and intangible outcomes more readily identifiable.

... hubs provide a robust mechanism for competitive collaboration ...

However, the key to success for innovation hubs is the ability of organisational leaders embarking upon such development, to take on both a governing and an empowering role. Whilst maintaining a future focus on managing an innovation portfolio, a hub leader should also embrace impact-driven operational accountability that fosters partnership development to drive co-creation and informs the decision-making processes within a hub's ecosystem.

INVESTING IN INNOVATION

Different investment models in innovation hubs could be considered. The simplest is to provide a separate budget for hub development with its own P&L. However, this approach may not necessarily render the best returns. Alternatively, adopting a partnership model for investment with stakeholders (eg supply chain, customers), could potentially extend the opportunities and benefits.

In fact, hubs provide a robust mechanism for competitive collaboration. Again, pharma companies tend to do this well in tackling issues during drug development or a clinical trial stage. Such models can offer a scaffold structure for any sector to consider.

A third option for investment in hubs could be to employ an aggregator concept, where the participation of many stakeholders, particularly small and medium size enterprises, is encouraged. Universities and colleges could adopt such a model as it naturally lends itself to a wider collaborative innovation development.

INCENTIVE PRIZES AND THE ADVANCEMENT OF SCIENCE AND TECHNOLOGY

Paul Ridout
Ocean Scientific International Ltd. (OSIL)

There is a wide range of high-value incentive prizes on offer for the development of technologies to help solve some of today's scientific challenges. The intellectual value of such prizes may be much wider than the original challenge. Details of the recently awarded Wendy Schmidt Ocean Health XPRIZE demonstrates some of these benefits.

During the18th century, the British government offered more than £100,000 in prize money to anyone who could come up with simple and practical methods for measuring longitude to assist maritime navigation. In 1927, there was the $25,000 Orteig Prize, for the first non-stop transatlantic flight. In 2004, the $10 million Ansari XPRIZE was awarded to the first non-governmental organization to launch the equivalent of a three-person crew into space twice within two weeks. More recently the Longitude Prize has been launched which offers a £10m prize to address the problem of global antibiotic resistance. In July 2015, the $2m Wendy Schmidt Ocean Health XPRIZE was awarded to the teams who could improve the accuracy and affordability of ocean pH sensor technology.

Incentive prizes, which offer large cash rewards to motivate the attainment of targets in

scientific research and development, have increased in popularity in the last decade. It is argued that this type of funding could effectively solve a wide range of today's science challenges. Although incentive prizes have long been used and

Electrical Interference Testing and Ozone Testing

may have led to valuable discoveries and inventions, little empirical evidence has been around to understand how prizes work.

In his book, 'Technological Innovation and Prize Incentives', Luciano Kay *(University of California Santa Barbara)* seeks to understand the effect of such prizes on innovation. Some of the key points in his findings are that prizes can induce new R&D activities, re-direct ongoing industry projects and that well designed prizes induce innovation over and above what would have occurred anyway. In addition, prizes may induce technological breakthroughs. However, according to Dr Kay, there are significant funding requirements, by the entrants, in order to carry out the projects and bad economic conditions may slow down (or in some cases, halt) R&D activities to find solutions to the prize challenge.

In this article, I seek to understand more of the processes and effects of incentive prizes by focusing on a recently awarded prize from the USA-based charity, XPRIZE. The XPRIZE philosophy is to incentivise a solution to a problem with challenges that are audacious, but achievable and tied to objective, measurable goals. Groups of experts identify areas of scientific and technological need and then seek to find sponsors for individual projects. One of their 'Grand Challenges' includes Energy and Environment, which has a goal to generate breakthroughs in clean energy, climate change, energy distribution/storage, energy efficiency/use, and water resource management. Previously awarded prizes in this area have included a project to inspire innovative methods to improve cleanup at sea following oil-spill incidents.

The latest award has been the Wendy Schmidt Ocean Health XPRIZE, which was launched in September 2013. This was a 22-month competition to develop accurate and affordable pH sensors to detect ocean acidification. Rising levels of atmospheric carbon are resulting in higher levels of acidity in the oceans, impacting the health of shellfish, fisheries, coral reefs,

... generate breakthroughs in clean energy ...

other ecosystems and our very survival (a topic previously covered by the P&SC). While ocean acidification is well documented in a few temperate ocean waters, little is known in high latitudes, coastal areas and the deep sea. Most pH sensor technologies are too costly, imprecise, or unstable, to allow for sufficient knowledge and coverage on the state of ocean acidification.

Over 70 teams from around the world expressed an interest in competing when registration opened and the final award took place in July 2015. Prize Sponsor, Wendy Schmidt has a keen interest in the marine environment. As President of The Schmidt Family Foundation, she works to advance the development of renewable energy and the wiser use of natural resources. In 2009, Wendy and her husband Eric Schmidt created the Schmidt Ocean Institute (SOI) and in

... higher levels of acidity in the oceans ...

2012 they launched the research vessel, Falkor, as a mobile platform to advance ocean exploration.

Teams participating in the Wendy Schmidt Ocean Health XPRIZE competed for two available prize purses: the $1M

Competition Phase 4 Testing

accuracy purse, based on performance, and the $1M affordability purse, based on cost and usability. In April 2015, 14 semi-finalist teams were narrowed down to the five finalist teams, representing four countries (Table 1). They embarked on a one week deep sea trial to assess ocean pH values throughout the water column at Station Aloha, a 110 square mile region in the Pacific Ocean, located approximately 100 miles off the northern shore of Oahu. During this six-day period, sensors were put through rigorous performance tests focused on accuracy and precision, while battling real-world pressure scenarios in water depths of up to 3,000 meters. To reach this point, teams had to successfully put their sensors through a three-month test in controlled laboratory conditions at the Monterey Bay Aquarium Research Institute (Autumn 2014), followed by a month-long performance test in a coastal environment at the Seattle Aquarium in February 2015.

On July 20th 2015 XPRIZE announced the first-place winner of both prize purses as Sunburst Sensors, a small company of chemists and engineers from Missoula, Montana, led by CEO and co-owner, James Beck, an engineer who graduated at MIT and University of Washington. They won the $750,000 grand prize in both the affordability and accuracy categories, earning them a total of $1.5M. Sunburst Sensors co-owner, Professor Michael DeGrandpre, is a Professor of Chemistry at the University of Montana, where he pioneered the development of an autonomous alkalinity sensor, in collaboration with Dr Reggie Spaulding from Sunburst. However, the competition's requirements were quite different from the sensors they were already producing with

Competition Phase 4 Testing – Hawaii

emphasis on fast sampling rates, deep-water operation, accuracy and affordability. The company concentrated on their previously developed commercial sensors to create the two winning sensors: the i-SAMI ("i" for inexpensive) and the t-SAMI ("t" for titanium). The team collaborated with Woods Hole Oceanographic Institution (WHOI) for development and testing of the t-SAMI deep-water instrument.

The second place prize in affordability was awarded to ANB Sensors from Cambridge, England, and the second place prize in accuracy was awarded to Team DuraFET from Plymouth, Minnesota and Monterey Bay, California. Each team won $250,000. During the course of the competition ANB Sensors formed their own start-up company and have been working on the second generation of their competition entry for market. Team DuraFET has donated their award money to the international ARGO program – a program that is deploying sensors in the global oceans to improve our understanding of the baseline state and any changes.

Professor Ralph Rayner, a British marine scientist who was a scientific advisor for the XPRIZE commented, "It is true that the prizes generally have an initial focus on stimulating technological innovation, but this is just the start of the process. The Ocean Health XPRIZE goal is also to raise awareness of ocean acidification and its potential impacts and there are a large number of post prize activities being planned in this regard".

Team Finalists for the 2015 Wendy Schmidt Ocean Health XPrize

- **ANB Sensors (Cambridge, England)**, a team of scientists and researchers from the Schlumberger Gould Research Center with expertise in lasers, chemistry, fluid mechanics and geophysics.
- **HpHS (Yokosuka, Japan)**, a team of research scientists and engineers from the Kimoto Electric Co., Ltd. and Japan Agency for Marine-Earth Science and Technology (JAMSTEC).
- **Sunburst Sensors (Missoula, Mont, US)**, a team of mechanical engineers from Sunburst Sensors, LLC, a company focused on the development of chemical sensors for marine and freshwater applications.
- **Team Durafet (Plymouth, Minn, US)**, a team comprising representatives from Sea-Bird Scientific, Monterey Bay Aquarium Research Institute (MBARI), Scripps Institution of Oceanography at the University of California, San Diego and Honeywell Aerospace Advanced Technology group.
- **Team XYLEM (Bergen, Norway/Beverly, Mass, US)**, a team representing two Xylem companies, Aanderaa Data Instruments in Norway and YSI in the U.S., with extensive work in commercializing high performance and reliable optical chemical sensors used in oceanography.

... a keen interest in the marine environment ...

The winner of both 1st prize categories, Sunburst Sensors, is a small company mostly working in a different market area and located about as far from the ocean as you can get in the US. In that respect, the prize certainly stimulated transfer of technology from one market to another. Many of the problems they had to overcome revolved around the usual issues that all of us suffer when working on technology to operate in the ocean, including high pressure, corrosion etc.

An example of innovation from 'out-of-the-box' thinkers was the Smartphin project. Environmental film maker, Andrew Stern, and engineer/surfer, Benjamin Thompson, teamed up to produce a sensor system which is embedded in the fin of a normal surfboard. Originally for temperature and salinity they developed the technology to include pH in order to compete for the XPRIZE. They made it to the semi-finals but progress doesn't stop there. Starting in November, 50 researchers from the Scripps Institution of Oceanography (SIO) will be screwing Smartphin prototypes into their boards and taking to the waters outside their workplace to compare data with the fixed sensors located on the SIO pier.

Award Ceremony, New York

The XPRIZE competition aimed to drive industry forward to produce the capability to provide meaningful data needed to take action and produce results. In a wider context the prize hoped to:

- Provide tools for the study and monitoring of ocean acidification's impacts
- Catalyze ocean acidification research
- Increase development of the ocean services industry – data, information and forecasting
- Inspire innovations in ocean sensing technology to monitor the health of the ocean
- Create both tools and support for policymakers and public officials
- Inspire the public to engage in solving ocean acidification

XPRIZE plans to launch three more ocean-based prizes in the next five years as part of the XPRIZE Ocean Initiative. The goal of this initiative is to launch impactful prizes and inspire other actions that put us on an unstoppable path towards healthy, valued and understood oceans.

It remains to be seen how many of these will be achieved but evidence to date is encouraging.