WHITE PAPER

PROBLEMS WHEN DIVING

BACKGROUND

Dive Market

There are no accurate figures on the number of divers in the world. Best estimates range from 5 to 7 million active divers[1]. There are about 1.5 to 3 million divers in the United States. PADI certifies about 527,000 new divers a year worldwide. It has issued over 10 million diver certifications since 1967.

Underwater Computing

Computers have rapidly become a part of our everyday lives. Approximately 20 years ago the first personal computers were being introduced into offices and some homes. Today, almost 50% of homes in Australia have one. Similar levels of uptake can be found in other parts of the world.

Whilst personal computers have gained wide acceptance and use on the land their introduction into the underwater environment has been both difficult and protracted. Until recent times computing devices of any form have been largely absent from the underwater environment.

New technologies are now starting to emerge that show great potential for improving diver safety as well as the accuracy and efficiency of underwater operations.

This paper discusses problems that are commonly experienced when diving in the underwater domain.

PROBLEMS

Four main problems are commonly associated with diving – irrespective of whether it is for work or recreation. They relate to:

1. Safety
2. Navigation and location
3. Entering and displaying information
4. Communication

Safety

SCUBA diving is regarded as an inherently risky activity. Quantifying the level of risk is difficult due to the paucity of data and the many different variables involved.

[1] PADI Diver Statistics. http://www.padi.com/english/common/padi/statistics/7.asp

The annual number of non-fatal accidents in the United States (where there is estimated to be between 1.5-3.5 million active divers) varies from about 600-900 divers per year[2]. The annual number of fatalities in the US since 1970 has varied from 66 to 147. This equates to 3-9 fatalities per 100,000 divers. For commercial divers the risk increases by a factor of about 500 (to 1 in 20)[3].

Typically, novice divers are most likely to suffer an accident. About 66% of fatal mishaps in Hawaii involved a diver with only basic SCUBA training[4]. The majority of fatalities involved "separation from buddy".

Typically, a dive begins and ends from the same fixed point - either on the land or water (eg. boat). It is at this point that dive support is organized and any rescue or retrieval is attempted. Frequently, a stand-by diver is on station in case of emergency – for quick rescue. This can often be a requirement by law.

It is often very difficult to track the progress of a dive from the surface. Waves, current and reflected light conspire to obliterate the telltale bubble trail of the dive party. How can a diver be quickly rescued when their location is in doubt? Quick response may make the difference between life and death. More often than not, the accident remains undetected until the dive party has returned.

Despite extensive planning and organization it is still very difficult to monitor the progress of a dive and to determine where a diver or group of divers is located. Accidents underwater can happen very quickly (panic is often involved) and any response needs to be almost immediate.

Key issues:

- Base doesn't know where the divers are and what their situation might be
- Diver is unable to contact base quickly if something goes wrong

Key Requirements

- Diver's location and general situation known at all times
- Diver can quickly alert base in case of an emergency or accident

Key Outcomes:

- Ability to quickly respond either before or immediately after an accident
- Reduction in the likelihood of an accident occurring and possibly its severity

Navigating and Location

Apart from space, the underwater environment is perhaps one of the most difficult of all environments to navigate within. This is because frequently there are no points of

[2] Blue Orb Syndrome. http://www.scuba-doc.com/bluord.htm. 3pgs.
[3] Scuba Diving: A Risky Sport? Dive Club Newsletter. Kingston. Ontario. http://arts.usask.ca/policynut/ducks .htm. 3pgs.
[4] Diving Safety Fact Sheet. Marine Safety Office Honolulu Fact Book. US Coast Guard. http://www.uscg.mil/d14/units/msohoho/factbook/divingsafety.htm 3 Pgs. 1999.

reference with which to navigate. Even when there are, it is then difficult to ascertain where one is in relation to a fixed point on the land (or the mother vessel). People can become disoriented – especially in calm conditions or in deep water.

Commonly, an analogue compass is used to navigate from one point to another. This is inaccurate and subject to the effects of current, waves, water clarity and diver condition. Commercial divers on North Sea oil rigs determine their position by identifying hundreds of markers (brass plates) located at various points along the platform structure, navy divers lay out long lines of string and markers to survey the seabed for mines.

Key issues:

- Methods of navigation are inaccurate; new technologies are now becoming available but they don't enable the diver's position to be shown graphically real-time – on a map;
- Manual methods (eg. lines and buoys) are required to locate and mark objects – these are generally inaccurate and lead to errors (often significant)

Key Requirements

- Real-time display of diver's position
- Ability for diver to navigate from one point to another; to set course and way points
- Ability to locate and mark the position of objects – on a standard map or chart

Key Outcomes:

- Accurate underwater navigation and position fixing with real-time display
- Reduced errors
- Greater safety
- More efficient operations

Recording and displaying information

Observational information is still recorded using paper and pencil – the way Darwin did it over 150 years ago! This is not only difficult to do (particularly if there are current and waves) but also time consuming. Frequently the information needs to be interpreted back at base and entered into computer - which can introduce further errors into the dataset.

Divers rarely take reference material (eg. maps, diagrams, manuals, species keys) with them as it is difficult to carry and access. Consequently, on contacting a mine navy divers usually have to swim back to the mother vessel, look up details of the mine, before heading back to disarm it.

Key issues:

- Observational data is recorded by hand, which is both time consuming and error prone;
- Further errors can be introduced when transcribing the data onto computer;
- Information cannot be easily taken with the diver and referred to

Key Requirements
- Ability to enter information directly onto a computer
- Ability to access information during the dive – leading to increased capability

Key Outcomes:
- Greater accuracy
- Fewer errors
- More efficient on time and resources

Communicating with other divers and the base

It's easy for divers to become separated or for something to happen to one without the other noticing. Frequently situations change and they need to be communicated to other members of the group or between the diver and base. Those at base need to be appraised of the progress of the dive to upgrade state of readiness in case of potential accidents. Improved communications can help to greatly increase the speed and effectiveness of any rescue efforts.

Through-cable communications are available and have been widely used but they can be dangerous to use in complex environments where the risk of a "Snag" occurring is high. Through-water acoustic communications enable operations to be undertaken over longer distances from the base as well as the transfer of digital information which is less error prone.

Key issues:
- Divers loose contact with each other or with the base station;
- Changes in circumstance are difficult to convey
- Operations need to be restricted in areal extent

Key Requirements
- Ability to transmit messages as well as data over short to medium distances
- Ability for communications between individual divers and between divers and the base station

Key Outcomes:
- Improved safety
- Improved situational awareness