

Breathe in. It's the only sound you will hear. Breathe out. Look at the bubbles in front of your face. You are 60 feet below the surface. You look up and see the sun shining through the blue water that is all around you.

Breathe in. You gently kick your legs and your arms are relaxed in front of your waist. You look to your left and a school of fish swims by in the coral reef habitat that is all around you. Breathe out. You look to your right and see a sea turtle the size of a coffee table carrying on with its daily activities. You are scuba diving.

Scuba diving is a unique activity that allows humans to extend beyond the capabilities of their bodies and come in touch with nature.

I found scuba diving intriguing because of videos I would watch when I was younger of the scuba dives my aunt and uncle went on. I was amazed of the

stories they would tell about how big the fish were, and I wanted to learn more about it because I did not know that much already.

My research project began when I attended Our World Underwater Scuba Diving Expo on February 14, 2014.

While I was there, I got to try scuba diving in a small pool. Even though I did not experience the



full effect of diving under the pressures of the ocean, I learned that diving was relatively easy because you breathe normally.

At the Expo, I interviewed several people and learned information about the equipment used while diving, in addition to important information on safety that was consistent with information I learned later on in my research.

I felt it was important to look at the history of scuba diving to see when it all began and how it changed into the activity it is today. After learning about the vast amount of information available on scuba diving I chose to focus solely on recreational scuba diving because I felt this information might be most valuable to my classmates, all of whom could potentially be future recreational divers.

Lastly, I had an interview with my Aunt Celeste and Uncle Wayne. They helped me clear up a lot of areas I was struggling to understand, specifically the information on physiological effects of scuba diving and how certain equipment works. I also found out why they continue to dive after almost 30 years.

My research process was very simple, with no major obstacles. It was interesting learning about scuba diving and I plan on getting certified in the near

future. In my paper, I will discuss the history, equipment, physiological effects, and certification of scuba diving and conclude with why people choose to dive.



History

There are four different types of diving: breath-hold, diving in a heavy walled vessel, surface air, and scuba (“Scuba Diving-Marinebio.org”). Breath-hold means a diver holds their breath and the time spent underwater is very short. If one is diving with a heavy walled vessel, they are not affected by outside pressures. Using surface air to dive is no longer useful but was widely used to dive in the past. SCUBA is really an acronym that stands for self-contained underwater breathing apparatus. This means that a diver holds a device that helps him or her breathe underwater.

The first instance of scuba diving traces all the way back to 1825 when William James invented the first self-contained underwater breathing apparatus (Smith, 45). His apparatus had a metal or copper helmet with a window, and an air tank was wrapped around his torso. As the years continue on, more and more people create their own apparatuses.

In 1865, two French men, Benoit Rouquayrol and Auguste

Denayrouse invent the “Aerophore,” a device that provides air on inhalation (US Navy). Compressed air was supplied from the surface by a removable hose connected to the diver’s tank on his or her’s back. When the hose was removed, the diver could swim around for a few minutes on the

air left in the tank. This is similar to the modern day demand regulator that provides air “on demand” however, at the time the device was not widely accepted.

Other people were still

experimenting with different materials to dive. According to the US Navy Diving Manual, Henry A. Fleuss developed a scuba system that used compressed oxygen instead of air in



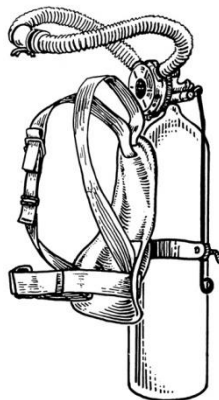
The Aerophore model, created in 1865. Google Images

1876. He used a closed circuit system where none of the air

escapes and the exhaled carbon dioxide is recycled through. His model was limited because breathing pure oxygen in deep depths is toxic but the system can last for multiple hours. More information about closed circuit systems is found on page 6.

Many physiological effects of diving were not well understood at this time. It was Boyle that first noted decompression sickness in a viper in the 1700s. John Scott Haldane performed research on decompression sickness upon request of the British Government in 1906 ("Scuba Diving-Marinebio.org"). Soon after in 1908, diving tables were created to tell naval divers how long they would need to decompress given the depth they swam and for how long they swam.

In 1933, Yves Le Prieur creates another scuba model after he modifies the demand regulator created in the 1860s. His model did not have a regulator and air is provided by opening and closing a tap ("Scuba Diving-Marinebio.org"). A lot of



Aqua Lung original design

air escapes and it could not be used for long periods of time.

It is hard to believe that up until this time, divers did not swim with flippers.



According to a scuba diving timeline from Marinebio.org, Owen Churchill first started producing swim fins in 1940 and now every scuba diver uses them to make underwater swimming much easier.

Recreational diving increased after World War II when Jacques Cousteau and Emile Gagnan patented the Aqua Lung in 1943 and sold worldwide in the 1950s ("Scuba Diving-Marinebio.org"). Gagnan was an engineer and he redesigned a car regulator and brought back the use of the demand valve created in the 1860s by Rouquayrol and Denayrouse. The Aqua Lung had a good reputation for being relatively

affordable and durable. Cousteau went on to making a lasting impact on the diving world, publishing many novels such as *The Silent World* in 1953 and even promoted that humans should live underwater when the surface became overpopulated.

Since the days of Cousteau, scuba diving has increased in popularity. However, safety has always been a concern. The National Association of Underwater Instructors (NAUI) formed in 1960 and the Professional Association of Diving Instructors (PADI) formed in 1966 (“Scuba Diving-Marinebio.org”). These organizations developed requirements for getting certified to dive and diving safety has improved significantly.



The last significant piece of history was the development of underwater diving computers. The Orca Edge was the first diving computer, introduced in 1983 (Scuba Diving-Marinebio.org”).

Diving computers changed diving because they no longer needed to be as calculated as they used to be. Before each dive, a diver would have to know at exactly what depth they would swim at, and for exactly how long, in order to calculate how long they would need to decompress. The computers calculate all of this so extra planning is longer necessary.

Equipment



All recreational scuba divers use the same type of equipment and it has evolved over the years. It is important for the comfort and safety of the divers.

Every diver needs a mask to see underwater and fins to help them swim



easier underwater. It is recommended that divers own these two pieces of equipment because they have different sizes and it makes the overall experience more comforting.

Recreational divers tend to wear a wet suit while they dive. A wet suit is a thick skin that creates a barrier between the diver and the water and uses the diver's body heat to keep them warm (Maynard). Depending on the temperature of the water, wet suits are not always necessary. Some other skins can be worn to protect divers from scratching the coral in reefs.

Dry suits can also be worn by divers, but it is not typical for recreational divers. Dry suits completely seal the body so it stays, like the name states, dry. Typically divers would wear dry suits when swimming in really cold or contaminated water (Maynard). Both

dry and wet suits help provide safety and comfort in the diving experience.

Divers also need a snorkel while diving. After a diver jumps in the water, they wait a few minutes for everyone else to jump off the boat. Instead of wasting the air in the tank, the divers use snorkels to breathe at the surface (NAUI).



Second Stage of Regulator

The breathing apparatus begins with the air cylinder that is on the diver's back. The cylinder can contain compressed air or

Nitrox, an oxygen enriched gas, and is supplied to the diver with a two stage regulator. The first stage of the regulator attaches to the cylinder itself and reduces the pressure of gas from the tank. The second stage connects to the first by a hose and reduces the pressure of the gas even more so it can be inhaled on demand (Smith 55).

When using a normal regulator, divers only breathe in and out through their mouth. A modern day invention was made to combine a regulator and a face mask into one system.

With this combination, divers can breathe completely normally with their nose and mouth if they would like. Most first time divers would still most likely use a normal regulator and mask but efforts are being made to improve the breathing experience.

Recreational divers breathing apparatus is an open circuit system. The system is open because compressed air flows in one direction. Air is inhaled by the diver and the exhaled carbon dioxide exits the system in the form of bubbles from the second stage of the regulator.



Invention of mask and regulator combination; photo taken at Scuba Expo.

As previously mentioned in the history section, there is also a closed circuit system that is utilized more in the military. The closed system does not let any air leave the system. The exhaled carbon dioxide is recycled back into the system.

No bubbles are created in the process so the position of the divers cannot be identified.

If the divers experience any problems with their breathing apparatus, such that they can no longer use their own oxygen tank, most divers carry an alternate air source with them. Another device is called an octopus which is a second regulator attached to someone else's tank. Two people can share the air from one tank (Dykshorn). Before the octopus a method of sharing air would

be switching back and forth with one regulator with another person.



Buoyancy control device is used to control depth.

Divers also need a buoyancy control device (BCD) and

lead weights.

Humans have a smaller density

than salt water so they naturally float.

The weights are used to sink and the BCD can be inflated or deflated so divers do not sink too quickly but also so they do not ascend too quickly when returning to the surface (Freudenrich).

Lastly, information gauges are used to tell divers their depth and amount of air left in their tank. This is the most important safety feature divers have. If a diver has a diving computer, this would also contain similar information, in addition to recording the

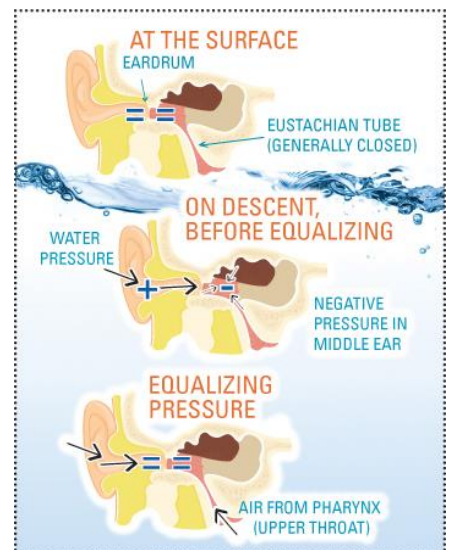
time of the dive. Computers make dives less calculated and because based on the information collected, they tell divers when they need to return to the surface and how long they need to decompress (Dykshorn). More information about dive computers is discussed in the next section.

Physiological Effects

The underwater environment is clearly different than that on the surface. Divers essentially move in a weightless environment and thus need to understand how their bodies would be affected under pressure.

A common effect of diving

experienced amongst all divers is pressure in the ears. This is a similar



Google Images

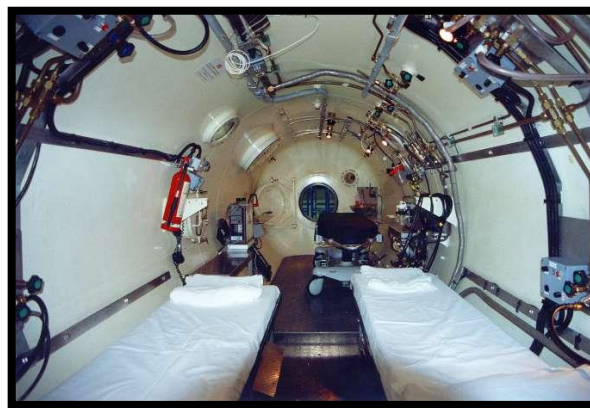
feeling to flying in an airplane except the pressure is increasing in the reverse direction. While a diver is descending, pressure inside the ears is being affected by the water pressure. To equalize the pressure, a diver can plug their nose and exhale. The Eustachian tube will clear the ears (Go Dive).

Second is decompression sickness, or the “bends.” While

underwater, the body absorbs nitrogen. The amount though, depends on the person and the depth they dive. Before computers, Navy Dive tables were used to calculate how long a person needs to “decompress” or stay underwater to let the nitrogen leave the body. The dive tables tell a diver that at a given depth, he or she will need to decompress for a certain number of minutes. The longer

and the deeper the dive, the longer amount of time is needed to decompress. The problem was that the tables were created for young men in the navy, and they were not always accurate in calculating the time needed for a typical recreational diver

(Dykshorn). If affected with decompression sickness, a person will need to go to a recompression



chamber, as seen in the picture above, immediately.

Diving computers are used to tell divers how long they need to decompress because divers do not always swim at the same depth during a dive. On ascent, divers will make a “safety stop” for 3 minutes at a depth of 10-15 feet to make sure all the nitrogen has left (Dykshorn). It is important for all

divers to ascend slowly after their dive to make sure they do not experience decompression sickness.

Another problem that could be faced when divers ascend is a gas embolism. This is a collection of bubbles in the lungs caused over pressurizing the lungs. This occurs if a diver holds their breath. Boyle's Law states that pressure and volume are inversely related. On descent, pressure increases, so the volume decreases. If a diver is constantly breathing, his or her lungs will increase and decrease in size normally. However, if the diver were to hold his or her breath while ascending, the pressure is decreasing, which likewise means the volume increases. The volume of the lungs would double or triple causing over expansion and possibly a collapsed lung (US Navy). All of this is easily preventable if a diver

does not hold his or her breath at any time (NAUI).

Lastly, a diver can experience nitrogen narcosis, commonly referred to as Martini's Law. This occurs on the descent, around 100 feet below the surface but depends on the person. This is essentially the anesthetic effect of nitrogen (Dykshorn). People feel like they would if they had laughing gas and they do not always make the best decisions because they feel too breathe with their regulator and end up drowning. But that is one of the worse case scenarios. When most divers start to ascend again, the anesthetic effects completely disappear.



The potential issues of scuba diving are very dangerous. However, most divers will not need to worry because it is very easy to prevent any of these problems. The two most important things to remember while diving are never hold your breath, and always ascend slowly (NAUI). All of these physiological effects would be learned while a diver is getting certified.

Certification

In order to dive, a diver must first be certified. A person must be at least 10 years of age (Go Dive). This age was chosen as the minimum because scuba diving is essentially similar to being on life support while below the surface. People need to be mature enough so they could make the right



decisions because their life really does depend on it.

Scuba diving does not require a person to be a highly skilled swimmer. However in order to be certified, one must be able to swim 200 yards and float in deep water for at least 10 minutes (Go Dive). These are skills you would need on an actual dive so it is important a diver can minimally perform them.

Scuba certification programs tend to be around 3-7 days in length and consist of classroom type learn and shallow pool experience as shown in the picture (Ingram).

Divers learn about how the body is affected by diving, and what to do when something goes wrong. A diver must also complete four open water dives in order to be certified. The cost varies from each dive shop. An Open Water

Scuba Class at Toucan Dive in Lake Villa, IL costs \$359 and each open water dive costs extra as well (Toucan Dive).

Scuba certification programs are developed by a training organization.

Typically this organization would be NAUI or PADI. These organizations were created in the 1960s so divers would understand more about how their bodies were affected by diving, and the accidents caused from diving decreased as a result. Since its creation in 1966, PADI has certified more than 22 million divers worldwide (Ingram).

There are different levels of certification that the organizations offer and to move up, one needs experience. The basic certification is an Open Water Diver. This diver knows the basics about diving, but do not have a lot of experience.

The next level is Advanced Open Water Diver. These divers have more experience and go diving more often. They are capable of diving deeper and in different places like shipwrecks or caverns (Toucan Dive).

Becoming a Rescue Diver takes a lot of practice and training for all different types of situations, which is why it is the next highest level. Rescue Divers must have a lot of confidence in order to help people in life threatening situations.

Finally, the last level of certification is Dive Master. Dive Masters must have at least 50 dives recorded and they can be in charge of a group of divers (Go Dive). They must meet all other levels beforehand.

“Diving is a simple thing; the hard part is confidence” (Dykshorn). Being able to physically dive is not a difficult

“Diving is a simple thing; the hard part is confidence.”

task because everyone knows how to breathe and swim. Confidence grows with time. The more diving a person does, the more comfortable and confident they will feel about their abilities.

Conclusion

People go scuba diving because it is a unique and thrilling experience. They are doing something their body was physically not built to do.

Scuba diving can be expensive, but for the avid divers, it is worth it. "I like knowing that the equipment I am using works properly because it is mine" (Dykshorn). While the equipment is expensive, it is high quality and can last for a long time. Renting is still a possibility for scuba divers. It is still recommended that a diver uses his or her own mask and fins.

The sights are another reason people are drawn to scuba diving. While



Hammerhead Shark in Cocos Island, Northern Galapagos

on a dive, a person will see lots of wild life and fish. Other sites divers can explore are ship wrecks and caves. It is a chance for people to be up close to nature and take a look back in history.

One of the best experiences during my research was actually trying the breathing apparatus in the pool. I had a nervous yet exciting feeling when I put my fins on and all the other equipment. I did not know what to expect with the breathing apparatus but I was pleased that it was so simple to breathe under water because it did not need any extra effort on my part.

Potential divers should keep a few things in mind before they decide to get certified. It is important that if one plans on getting certified, one should also plan on going scuba diving in the future. Cost and time are also factors because getting certified and the rest of the equipment that comes with it can be costly. A person also needs to take time to get certified. Lastly, people should always remember that scuba diving is not that dangerous because it is easy to prevent potential hazards. Being afraid is no reason to not go diving. The sights and the feeling of total relaxation are worth it.

Throughout my research process, I was constantly fascinated by what I would learn about scuba diving and I wanted to get certified to start my experience right away. I know that scuba diving will be an activity that I will pursue in the future. With a planet that is 70 percent water, it is amazing what can be found just beneath the surface.





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