History of Diving

Since before recorded history, man has held a fascination with the underwater world and has sought to explore these environments. Through this chapter we will investigate the origins of diving and the innovation of technology so that we may best appreciate the developments of our modern diving industry.

The first written origin of breath hold diving dates back to 2700 BCE in the Epic of Gilgamesh in Mesopotamia. Well before the time of Archimedes and the codification of buoyancy, stones were used to help man hold their breath and stay submerged underwater. Artwork dating back to 2000 BCE shows of the first portable air source in the shape of a bag from animal hide. Bas relief embossments from the British Museum dating back to 900 BCE show of men underwater using pig skin bladders. However, the pressure would compress the volume inside the bladders and didn’t have a mechanism to deal with carbon dioxide exhaled back into the bags. These were the first “rebreathers” and would not surface again for hundreds of years in history. What is considered the first innovation in diving technology, came from the ancient Greeks.

Around 500 BCE, Greek history documents the use of hollow reeds to breath from while remaining underwater. These bamboo segments of sorts became the first “snorkels.” The idea was thought to have originated from observing elephants swim while holding their trunks above the surface. In the hopes of staying deeper underwater, Greek innovators cut long branches of reed to breathe from which unfortunately did not work. Today we know this is due to hydrostatic pressure exerting on the airspace inside the reed. Reed technology only extended to about 0.5m. This
posed to be live-saving as Greek soldier Caelus hid himself below the waves from the Persian king, Xerxes. The next innovation in diving technology would come from none other than Alexander the Great.
Alexander the Great descends in the *Colimpha* (Photo credit: TheDivingAlmanac.com)
In his essay, “Problemata,” Aristotle recounted the brilliance of his student, Alexander the Great, for using the first “diving bell” during his victory at the Siege of Tyre in 332 BCE. Artwork depicting the battle shows Alexander descending into a glass barrel known as the “Colimpha.” He regaled accounts of witnessing sea monsters and demons. Nevertheless, this was man's first “diving bell” and peak development of these wouldn’t advance until the 16th century.

One of the greatest inventors of history, Leonardo da Vinci, was recruited by the Venice military to design an apparatus that would allow divers to attack the Turkish ships during the War of Cyprus. His reinterpretations of old technology as sheepskin bags and 18" breathing tubes proved to be unsuccessful. But war was not only the motivator to advance humans below the surface. Submerged ships with their treasures spurred invention for salvage operations. Diving bells that entrapped air vertically could allow men to do their work and return to the bell for another breath of air while remaining submerged. The most successful design of the diving bell came from English astronomer Dr. Edmund Halley. He conceived of casks being lowered down for salvage and bridge repair operations. If only there were a way to provide more fresh air in these bells for longer?
Edmund Halley’s diving bell (Photo credit: The History of Diving Museum)

In 1788, the first “pump” was developed to do just that. Now continuous fresh air could be pumped down to the bells and became wildly popular throughout ports. But it was fire that led to the next crucial development in diving technology.

Two English firefighter brothers, Charles and John Dean developed a smoke helmet that would allow them to enter a burning building. Augustus CB would later partner with them to create the first patent designed for underwater application. The
metal helmet had an umbilical cord that pumped in fresh air to a diver underwater. However this was a dangerous design as you couldn’t lean forward or else water may enter the helmet! In 1837, CB would modify that design so that it would remain watertight with exhaust escaping at the top. This became known as the “CB helmet” and largely replaced the diving bell for salvage operations, spurring the birth of the commercial diving industry. As compressor technology improved, man dove deeper and deeper which led to their next obstacle... decompression sickness (which we will talk about in another chapter).

In a nutshell, the compressed gas divers would breathe became absorbed into diver’s tissue compartments and would manifest as bubbles on ascent from long or deep exposures underwater. After John Scott Haldane published his first stop times models in 1907, the first dive tables, divers were now equipped to manage their dives. Unfortunately though, they were bounded to their umbilical, there how to be a way to break free of this leash.

The first compressed gas SCUBA, self contained underwater breathing apparatus, was developed in 1825 by Englishman, William James. It consisted of a huge air reservoir that was worn around the waist with boots allowing divers to walk. An innovation
from coal miners overcoming deadly methane gas would prove to be the next critical step for SCUBA technology.

Designed by a French team, their SCBA, self contained breathing apparatus, had an umbilical that could pump fresh air to rescuers during cave-ins but also disconnected. This 1860s system, the Rouquaroll Denayrouze Apparatus, was limited by the lack of gas supply compression, as the system only contained about nine breaths. However, this was a huge innovation because of the regulator design. Their regulator deliver gas on-demand, instead of a constant flow system. It would be another 78 years before Emile Gagnan and Jacques Cousteau would rewind the demand valve that we use in SCUBA today.

The Rouquaroll Denayrouze Apparatus in action (Photo credit: DivingHeritage.com)

However it’s worth mentioning that the development of rebreathers parallels with that of compressed gas diving. To a large degree, rebreathers were our first form of independent “SCUBA.” Over 150 years before the Rouquaroll Denayrouze Apparatus, botanist Stephen Hales designed a primitive system that used a flannel cloth soaked in salt, sodium chloride, and
calcium phosphate as a CO2 absorbent. This was also designed for cave rescues however users would sometime suffer from what we now know as “hypoxia,” or the lack of oxygen. Even though it would be another 50 years before Clark Scheele and Joseph Priestley would discover “oxygen” and how vital it was in the air we breathe. Fast forward to 1878, Henry Fluess receives the first patent for a portable underwater breathing apparatus, and what would be the first true rebreather. His partnership with Augustus Siebe and the Denae brothers yielded a rubber waterproof breathing mask, breathing bag, hoses, a copper cylinder charged with 450psi of oxygen and a CO2 absorbent caustic potash mounted on the diver’s back. This technology, oxygen rebreathers, would become wildly popular in military for naval stealth applications due to their bubble-less design.

The Fleuss rebreather, the first independent SCUBA and true rebreather system (Photo credit: the History of Diving Museum)

The birth of the recreational diving industry begins in 1935 with Austrian marine biologist, Hans Haas. Donning an oxygen rebreather, Haas was the first to film life and started a fascination for our underwater world. However the legend that would transform our sport and “go down” in history was French naval officer, Captain Jacques Cousteau who developed the “Aqua Lung” with Emile Gangnon. Modifying the Rouquaroll Denayrouze regulator, the iconic double hose system delivered gas on-demand that allowed divers to explore the world Hans Haas
began portraying. The Aqua Lung made SCUBA commercially available, revolutionizing the recreational diving industry, as they would eventually lead as the Aqua Lung brand that is still around and widely popular today. Cousteau’s passion for exploration and documentation are what have earned his fame as one of the most influential men in recreational diving. His son, Jean-Michel Cousteau, recounted the times his mother would hand cut and glue 35mm film for Jacques’. Cousteau’s expeditions and the TV show “Sea Hunt” with Mike Nelson, created a culture of divers originating in Southern California and eventually, the world.

Emile Gagnan and Jacques Cousteau gearing up for a dive in their Aqualung regulators (Photo credit: Pinterest.com)
History of Scientific Diving and AAUS

The popularity of diving was fueled by commercial, military and recreational applications. There was one group that took to diving with extreme interest and those were scientists. Dr. Silvia Earle was one of the first to adopt SCUBA for research. At the time most marine biology was done by examining preserved specimens, fishing for samples or trawling. Earle described, “if you could imagine conducting the US Census with a net?” Diving opened up a whole new world for science.

Scientists sought to dive deeper and stay longer for their research. US Navy surgeon George Bond discovered the concept of “saturation.” After a seven year study, he concluded that once a diver absorbed all the nitrogen it could, then decompression time no longer increased. It made no difference if the diver stayed down for one day, one week, or one month, once in saturation. Now all a diver needed was a “house” pressurized to their working depth to live in underwater. In the mid 1960s, the US Navy built three marine stations for these nicknamed “aquanauts,” coined after the deployment of astronaut Scott Carpenter with his team of ten men that spent 45 days at 205 feet in La Jolla, CA in Sealab 2.
Pre-mission photo before the deployment of the Sealab II to 205 feet with Commander (and astronaut) Scott Carpenter (front row, far right). (Photo credit: Naval Undersea Museum)

In 1986 the George Bond, the father of Sealab and saturation diving, habitat was constructed in Victoria, TX. After escaping Hurricane Hugo and seeking repairs, it was moved to the Florida Keys in 1993 and was renamed “Aquarius.” Resting at 20m (66ft), Aquarius has made historically significant contributions to coral reef research due to saturation diving applications. Originally
operated by National Oceanic and Atmospheric Administration (NOAA) and the University of North Carolina-Wilmington, today Florida International University assumed operational control.

The Aquarius habitat, it still rests at 20m off the Florida Keys awaiting donations for the next mission (Photo credit: Reddit.com)

But not all scientists can afford $30k per hour for a saturation dive! Well before Aquarius, scientists like Sylvia Earle were using SCUBA for research. **Commercial diving**, that is, a **working dive under compensation (which can involve construction, retrieval, maintenance, inspection, welding, repairs, deep sea exploration, and photography)** has been around for hundreds of years. It is recognized by the Department of Labor under the
Occupational Safety and Health Administration (OSHA) under Code of Federal Regulations (CFR) 29, section 1910, subpart T. By definition, scientific diving is considered commercial diving in that it is occupational work. Since commercial diving predates scientific diving, science diving fell under commercial diving standards under OSHA. This meant researchers had to adhere to strict protocols, equipment and regulations that commercial divers were exposed to although they weren’t working with lift bags or underwater power tools. Is it fair that scientific divers fall under the same guidelines although the work is different?

Commercial divers welding repairs to an oil rig support beam (Photo credit: Oceaneering)
In the 1975, a petition was filed by the United Brotherhood of Carpenters and Joiners of America (AFL-CIO) that urged an emergency temporary standard (ETS) be issued with respect to scientific diving operations for their contracts. An ETS was granted on July 15, 1976, temporarily allowing for a different set of scientific diving standards. However, this was challenged in the US Court of Appeals by several diving contractors that thought this was unfair. The ETS was withdrawn in November 1976 and a permanent standard was crafted in effect on October 20, 1977… scientific diving was not exempt from OSHA 29 CFR 1910.

The American Academy of Underwater Sciences (AAUS) was formed in 1979 to petition OSHA an exemption to the commercial diving standards. Their argument for this was due to the consensual standards developed by best practices over 20 years, low accident incidence rate, and the self-regulating body that they would create. The final ruling was granted and became in effect on November 28, 1982.

Scientific diving, defined by OSHA 29 CFR Section 1910.402, is diving performed solely as a necessary art of a scientific, research, or educational activity by employees whose sole purpose of diving is to perform scientific research tasks. The exemption is granted to approved AAUS organizational members (OMs) that have a 1) diving safety manual and 2) diving control board (DCB).

The diving safety manual must include at a minimum:
- procedures covering all diving operations specific to the program
- including procedures for emergency care
- recompression and evacuation
- criteria for diver training/certification.
The diving control board (DCB) will have a majority of its members that are active scientific divers that shall have the authority to:

- approve and monitor diving projects
- Review and revise the diving safety manual
- Assure compliance with the manual
- Certify the depths to which a diver has been trained
- Take disciplinary action for unsafe practices
- Assure adherence to a buddy system for scuba diving

**The DCB has autonomous and absolute authority over the scientific diving in the program’s operation.**

Scientific divers deploy a quadrat to conduct benthic composition analysis (Photo credit: Jeff Kuwabara)
Under OSHA 29CFR 1910.410 (2)(IV) Appendix B to Subpart T, the purpose of the project using scientific diving is: the advancement of science, therefore, information and data resulting from the project are non-proprietary. Furthermore, the tasks of a scientific diver are those of an observer and data gatherer. Construction and trouble-shooting tasks that are traditionally associated with commercial diving are NOT including within the confines of scientific diving. By definition, “scientific divers” are based on the nature of their activities and must use scientific expertise in studying the underwater environment as scientists or scientists-in-training.

AAUS currently consists of over 100 organizational members (OMs) that include universities, marine labs, museums, aquariums, and others involved in scientific diving activists throughout the United States and world!

**The mission of AAUS is: to facilitate the development of safe and productive scientific divers through education, research, advocacy, and the advancement of standards for scientific diving practices, certifications and operations.**

For more information on the regulations and definitions outlined by AAUS, please consult your OM’s diving safety manual or consult the AAUS Scientific Diving Standards.