DIVING 2001
Hannes Keller
(Oceans 2000, 1973)

It is a great privilege and pleasure for me to run through some of the problems of the future of man in the sea. I will concentrate on three topics: the scuba diver, the underwater sea quest and homo aquaticus.

Many of us are now chiselling at the limiting factors of diving; we dream of extended no-decompression diving. The problem of decompression lies in the fact that one cannot dive deep with oxygen alone because it is a very poisonous gas that men can only support in small quantities. In diving, one must mix this powerful oxygen with harmless gases such as nitrogen, helium and so on. These gases diffuse into the body, stay there like blind passengers accompanying one on the dive, and do not react with the body chemically. But, when one returns to the surface, these slow-witted non-reacting gases come out of the body, and if one is not making a slow and tiresome decompression, form dangerous bubbles in the body. This very much limits the freedom of the diver.

There are four hypothetical methods of getting rid of the need for decompression: drugs preventing bubble formation; non-inert breathing gas mixtures which are chemically absorbed by the body; liquid breathing mixtures instead of gases, and extra-corporal blood circuits (the lungs being filled with a liquid).

Drugs Preventing Bubble Formation: When the gas pressure in the body tissues versus ambient pressure exceeds a ratio of approximately 2:1, we get bubbles. This limits diving with scuba to between 100 and 200 ft. For greater depths one needs industrial diving techniques such as decompression chambers and submarines but drugs may now change the critical ratio. Today, I believe that some 20 per cent improvement could be realised, and in the future, super-effective drugs might double or treble the ratio, but at this point one certainly reaches the limits of what chemistry can do for you.

Depths for scuba diving could be doubled or trebled, but one would be forced to use helium instead of nitrogen for breathing. However, helium saturates the body 2.64 times faster than nitrogen, and this would again take us back to short decompression diving at shallow depths.

We can estimate, therefore, that a suitable drug applied to a helium-nitrogen mixture would allow the scuba diver to go to depths of between 200 and 400 ft. This does not sound terrific for the magical year 2001, but it would mean that really black depths would be open to everyone, and that certainly would be a moving experience.

However, if there were a gas that would mix with oxygen and which could be absorbed by the body without poisoning it, it would give us diving without decompression. Very hypothetically, such a thing would look like this: at 300 ft, we would have a mixture of 5 per cent oxygen, 45 per cent xx, 45 percent UU plus 5 per cent corrector-catalyzer mixture (whatever that means!). The blood plasma would form an xx plasma, and UU plus tissue fat would make U fat. Then the xx plasma plus the UU fat would form a green liquid! The green liquid would dissolve in the blood, be filtered by the liver and leave the body with the urine.

The 5 per cent corrector-catalizer mixture would do some very odd jobs indeed.

When it came to ascending to the surface, all the gases would have disappeared; nothing would be left for bubble formation and no decompression would be needed. We could expect the gases like xx and UU, being non-toxic, to have molecular weights of 60 or more. Such gases have critical points of 500 psi maximum, therefore, we cannot expect to be at depths greater than 1000 ft.

Breathing Liquid: This has been discovered by Professor Kylstra. It is fantastically simple: one just drowns in physiological salt water which is saturated with oxygen, but instead of saying "Farewell beautiful world" one stays alive. It must be done at depths in excess of 300 ft, or the farewell would be final, since the liquid cannot hold sufficient oxygen at a lesser depth. Maybe new liquids will overcome this, but for anybody who can beat his psychological barriers against it, it is a great way to solve all diving problems!

Extra-Corporal Blood Circuit: The technique for this is, in a way, similar to the liquid breathing method. One fills the lungs with a suitable liquid and one may or may not continue to breathe. An artery or vein is cut and interrupted, the blood being guided through an apparatus which one may carry under the arm. The apparatus does the lungs' work by getting oxygen into the blood and carbon dioxide out of it. So, after joining a diving club, the diver sees his surgeon, gets his plugs installed and has no further diving problems. Whenever he feels like going underwater he just pays his electricity bill, connects the apparatus and drowns a little bit! The diver could now reach the absolute limits for diving - the depths could be as much as 5000 ft. But then the body chemistry could become upset - under the extreme pressure the metabolism would change delicate equilibrium with fatal results. Such changes of metabolism occur when one changes body temperature. Very roughly, one can say that each 1000 ft. is equivalent to a degree Fahrenheit body temperature change. The effect is much too complicated to be compensated by drugs, so I believe that the limit of diving is between 3000 and 7000 ft. Naturally, one day some crazy chap will make it 7043 ft.!

For the scuba diver, descent and ascent rates will be a big problem. (I once made a descent from 300 to 1000 ft. in two minutes, but I admit that I did not feel too great). Today, one understands that pressure changes cause specific problems that limit ascent and descent rates to between 100 and 300 ft. per hour at depth.

For the properly equipped sports scuba diver of the future, I would expect dive durations of six to eight hours, the one big problem being that of opening the energy gap. To heat a swimming diver, a suit must generate approximately 500 watts; with propulsion and rapid water velocity cooling him, the diver needs 1000 watts. Propulsion (if only we could think of a small torpedo that could be carried on the belt or between the legs) requires another 1000 watts. We want about eight hours duration - and here we have a tremendous battery problem. We can manage with 1000 lbs of lead acid battery, or with 200 lbs of silver zinc battery, or with 40 lbs of liquid oxygen and hydrogen plus a fuel cell, or with atomic power - if atomic power can be provided and if the small isotope battery is ever constructed.

A diving suit must give protection without hindrance; thermal, mechanical, optical and logistical protection. The materials of the future will be strong enough to make you laugh very loudly when a white shark tries to chew you, but the point is that the suits will be strong enough to be blown under pressure if you surface accidentally and need pressure for the prevention of a decompression accident. Then, naturally, the suits will allow efficient buoyancy control in conjunction with the breathing apparatus and electronic black box.

At present I am working on a suit which completely protects a diver from the hazards of drowning: if the diver loses consciousness, he will continue to breathe and automatically drift to the surface instead of being lost at depth. Rescue will then be easy. Such dry suits will even beat the wet suit for comfort.

Electronics: Today, Hewlett Packard markets a pocket computer which has forty thousand transistors, taking care of all basic mathematical functions of trigonometry and so on. Very soon somebody will make such a thing for divers and your dive will become almost automatically controlled. The box will provide a continuous dive plan, including return to base, control of vital body functions, supervision of overall safety and precautions, computation of optimal procedures in case of failure and trouble, control of breathing apparatus, automatic control of ascent in case of unconsciousness, communication to other divers and base, and navigation relative to base, divers, target, surface and bottom. Some of this data will be received by the diver via the apparatus.

A laser beam projected on to the faceplate will give a three-dimensional holographic display of the navigational situation, including one's own path underwater, the positions and movements of other divers and the position of base, surface, bottom and target.

Maybe ultra violet light will penetrate depth and dirty water, and provide visibility. The navigation system will be provided by means of ultra sonics, maybe electro-magnetic waves, and probably inertia systems as those in submarines and jumbo and fighter planes, only much less precise and costly.

The future belongs to a variety of breathing apparatus, and although nothing will ever beat the simple aqualung, we will have miniature compressors silently filling our cylinders over-night, and a small scuba set fitted with 8 lbs of air will weigh approximately 20 lbs, including the air vaporizer.

In the closed-circuit deep-diving apparatus, CO_2 and other contaminants will be frozen out of the circuit; no filters will be needed, and buoyancy will be easily controlled.

So, what I predict is this. The oceans are not dead. In 2001 I hope still to have the choice of jumping nude into the water and playing with the mask, fins and snorkel I bought in 1960, but the miliatary divers will swim around silently with an extra-corporal blood circuit, and some enthusiasts will breath liquid far down at 3000 feet. Naturally, it will be great to be able to move hundreds of feet up and down, with propulsion, naviagation, communications and, last but not least, liquid gases.

Living Underwater: The earth is becoming somewhat crowded; there is a tremendous energy-gap, and there is a contamination problem. In the 19th century, people had great problems in protecting themselves from contamination inside the house - outside, nature was healthy. Today it is different. Last week I was in New York - I am told that breathing air in a New York street is equivalent to smoking 40 cigarettes a day, and that one cigarette shortens life by 15 minutes; one day in New York therefore shortens my life by half a day. However, I was in a hotel which advertised filtered air, so I spent as much time as possible in my hotel room so that I was safe from contamination!

I believe that the future belongs to three-dimensional structures, towns which are completely closed shells. Inside such shells one would be able to keep the air conditioned and to filter out all contaminants.

A sociologist told me that the ideal city has one million inhabitants. Such a city could be designed as a cube, as a sphere, or other three-dimensional shape. A 0.6 x 0.6 x 0.6 mile cube would give each person - child or adult - one thousand cubic metres of space, which amounts to about twice the volume of a complete six-roomed apartment, including a garage. In such a cube people would live and work and communicate.

The first advantage - elimination of the energy gap: whatever energy the industry in the centre would use would heat the apartments. Secondly, people could commute easily with elevators and mechanical stairs - everyone could walk anywhere in 15 minutes. Thirdly, climate and contamination would be under control, with minimum technology needed. Fourthly, Nature would be within 10 minutes walking distance and could be kept intact for agriculture and recreation and joy - no more fences and houses anywhere - all would be one really nice big garden. Fifthly, it would be economical. Lastly, social contact would be optimal: one would have all the human contact one wanted, plus rooms for privacy for, naturally, to be happy, one needs a room in which to he alone - without acoustical or optical contact with the outside.

It has been proposed that we build such structures underwater. I am afraid this is not possible. It would be economic nonsense because of a simple physical law: a city underwater has to be of the same density and weight as the water it displaces.

If a structure is made of concrete, then 40 per cent of its volume would have to be of solid concrete; a room 21 ft wide would have concrete walls 3 ft thick. If made of steel, 13 per cent of the entire volume would have to be of steel: a room 25ft wide would need solid steel walls 1 foot thick. For buoyancy reasons alone, an underwater city would require several times more building material than a sky-scraper structure on land, which makes a nonsense of the whole idea. If one thinks of heavier materials, of the costs and quality of this magnitude, it is impossible

Floating cities - Yes! If one needs cooling, the water under a city would inevitably carry away heat energy. In a hot clinmate this is wanted, not so in a cold climate. So, certainly, Miami 2001 will float, while Oslo 2001 will be on solid ground where minimum heat is lost.

To Swiss people, the thought of a three-dimensional city filling a little valley with lots of people, all with their little bank accounts in the country, appeals very much. Actually, such structures have already been tried. The Egyptians once made big three-dimensional structures, but the architects only dared to move the dead inside. In Babylon, an architect tried, and when he failed because of an error in the calculations, found the greatest excuse I have ever heard. Since Babylon all architects have had their splendid excuses.

If underwater cities are impracticable, perhaps there is even less need for humans to acquire gills and cold blood and become homo aquaticus. Cousteau has predicted that selection and mutation will create new forms of human beings, capable of living fish-like underwater, for instance. But the human and his domestic animals have escaped the selection process from Nature - it is known, for example, that Eskimos are not hairier than Africans.

When trying to predict the future of mankind, we can certainly analyse some trends. One will try to permit the maximum number of individuals the experience of life. That means a big crowd! This crowd will certainly have to live in three-dimensional structures; the cities of the future. There is no need for humans to fly like birds as homoaeronauticus, or swim under the sea as homo aquaticus; if a city has 500 levels,

its three dimensions are enough. The factors limiting life will therefore be the energy-gap; waste of prime materials and contamination.

Other Trends: Each individual will seek maximum 'life fulfilment' which means a maximum of brain stimuli. Brain stumuli can be realities making an impression on nerves which then act on the brain, for instance, London Tower, or drugs, or electrical impulses - a computer could be connected to the brain to make it 'see' the Tower. But humans want not only a maximum of stimuli on the brain but also a maximum variety of stimuli. The brain wants to be able to choose its stimuli; it wants the freedom to choose and change. But the concept of homo aquaticus is profoundly opposed to these needs; aquaticus would have a very dull and one-sided animal life.

Another strong argument against aquaticus is the difficulty of maintaining body heat. The human metabolism is set at a very precise constant temperature, and homo aquaticus would need highly complicated chemical mechanisms to compensate for such temperature effects. The metabolism would need to be at least three times more complicated than it is already, and would probably be three times more prone to illness and malfunction. Nature dislikes such impracticable constructions.

If humans really want the maximum number of individuals surviving for the maximum time, then something else is needed.

Humans will not live in the sea, but they must become smaller - very much smaller. People only 3 ft tall could be as intelligent, sensitive, beautiful and as sexy to each other as people who are 6 ft tall. If humans could stop growing when eight years old, they would be easier to feed and to transport; less energy and prime materials would be used up, and more people could find a place on earth. Muscular effort could be implemented with tools. It could already be done today with hormones.

Finally, if by 2001 all the big fish have been shot, then at least a 3in fish, will be a great experience for a 3in diver!

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Brief Profile

Hannes Keller from Switzerland was the first man successfully to dive to the record depth of 1000 feet, and he did it as far back as 1962. Sadly, this achievement was marred by the tragic death of his diving companion, Peter Small.

Since then, he has concentrated on the technical development of safe and efficient underwater equipment for industrial deep diving, principally producing a professional suit and new chamber systems. He has also produced two-man and five-man portable recompression chambers.

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