

# HANNES KELLER...

## MAN BEFORE HIS TIME

On December 3, 1962, Hannes Keller, a young Swiss mathematician, stepped out of the diving bell Atlantis and swam around at the fantastic depth of 1020 feet off Catalina Island, California. With him in the chamber was British photo-journalist Peter Small, and on the surface was an anxious crew that watched through closed circuit television what was happening in the depths below. Also on the ship was Dr. Albert Buehlman, a University of Zurich medical professor who specializes in lung function and blood circulation. Buehlman had worked with Keller to develop deep diving methods and together they had masterminded the idea of alternating gases to shorten decompression time. Buehlmann had supported Keller as medical advisor during his early dives in Europe, and the 1000 foot dive was to put their theories to the ultimate test.

Sadly, the experiment ended in tragedy. Keller was only out of the chamber for two minutes, trying to plant a Swiss flag on the ocean bottom, when he began to feel dizzy. Realizing that he was running out of helium-oxy mix in his breathing apparatus, he returned to the air-filled chamber and immediately gave the signal for an emergency ascent. Then he opened his face mask breathing air now and lost consciousness. Peter Small had been instructed to open his face mask as well, but when he saw Keller pass out it is speculated that he became paralyzed with fear. The shouts from the surface through the telephone didn't seem to shake him, and eventually Small passed out. As the chamber was raised and pressure reduced to 150 feet, Keller still breathing the air inside, regained consciousness. He immediately opened Small's face mask and began artificial respiration, but it was too late. Small had suffered from anoxia (lack of oxygen) in the brain, and by the time he reached the hospital he was dead.

Although the entire dive was clouded in tragedy, controversy, and many unanswered questions, one thing still re-

mained: man had actually succeeded in diving to over 1000 feet. The theories of rapid compression and the alternating of gases had worked. The Keller dive stands as a monumental achievement when one considers that to date no one has surpassed that world deep diving record.

The Keller dive revolutionized all deep diving concepts. In today's oil fields the type of dive schedule that Keller tested over ten years ago is now making it possible for divers to work at greater depths. Keller has since gone on to work on the technical development of safe and efficient underwater equipment for commercial deep diving, including suits, chamber systems and decompression slide rules. Since he felt that the accidents on his 1000 foot dive were largely caused by the immobility and inefficiency of the diving suits, he set about to build a better one. About 200 new diving suits were sold worldwide, but in the end, it was converted into a ski-suit, was tested on the ski slopes of Switzerland and never got back to the water. The suits, made of a special four-way-anti-gliss stretch fabric, became the rage of winter sportsmen throughout Europe, were dubbed "Skin," and have since been adopted by international ski teams throughout the world. To date some 25,000 suits have been sold.

On all-too-rare occasions, Hannes Keller comes to the United States from his home near Zurich. During his last trip to California we were able to sit with this legendary man of the sea, to learn what has transpired in the 12 years since his record-breaking Catalina dive. Keller is the diving world's mad scientist — a delightful combination of genius and outrage. He talked about diving in the year 2001, related a few of his wild schemes in a heavily accented English punctuated with math formulae and algebraic equations, threw in a joke here and there, and in the end left us all in the dust. We found his ideas fantastic, far-out, but strangely believable — like he is.



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Text by Hillary Hauser — Photography by Jack McKenney

**SDM:** Hannes, how did you get started in diving? And what were the deep diving experiments that led up to your 1000 foot dive?

**KELLER:** Actually, I did some sport diving, beginning in 1958, and I immediately realized that diving was something worth pioneering, that one chap could answer the challenge with very limited means. This is not possible in the space industry, or most other industries. I felt that diving technology could be handled with a reasonable approach and that one could really do big things. So, I decided to solve the problem of deep diving.

I built my own regulator out of a piece of wood, because I only had the tools to machine wood, not to machine metal, and I learned to dive, myself, alone. It was crazy. I had something like three hours of diving experience, total, when I decided to break the world record. But then I didn't know what the world record was.

I found that in 1958 there were two records; for air diving it was roughly 430 feet, and the Royal Navy had gone to 600 feet in a simulated dive. So, O.K., I go to 1000 feet — a nice round figure. I found out that the diver Wookey of the Royal Navy needed 24 hours to come back from four minutes bottom time at 600 feet. This was ridiculous, so I set out to find a method for rapid decompression. But first I had to figure out what the decompression problems were.

**SDM:** How did you get together with Dr. Buehlmann? Didn't he help you with these problems?

**KELLER:** It was very funny. I wanted to use hydrogen, not helium, because I was looking for a cheap method. I suspected that hydrogen would chemically react and do bad things in the body, so I needed a doctor of physiology who could tell me the various reactions of hydrogen in the body. Somebody told me about Al Buehlmann, a professor of lung function at the University of Zurich Hospital. I went to him and asked him, "Well, what do you know about hydrogen in the body?" He couldn't understand at all why I wanted to use hydrogen, and I couldn't explain to him the problems of diving because I had no idea about it. He got interested in the project, and said, "O.K., I'll help you," and we started to work together. I knew mathematics, and he knew physiology.

**SDM:** What kind of equipment were you working with then?

**KELLER:** My very first dive I made with the cheapest diving method. For a diving bell I brought a 50 gallon gasoline drum. I paid one dollar for it, and made a diving bell out of it. I had a couple of large stones hanging on it, at the end of ropes. I kept my knife in my left hand to cut them off if necessary, and with my right I manipulated my air tanks, flowing air inside the drum. I had a couple of hand lamps, not diving lamps since I couldn't afford those, and I borrowed Aqua-Lungs from people. With that kind of equipment and a safety emergency ascent device made out of an old car tire, I went to 400 feet.

**SDM:** How were you feeling inside that drum?

**KELLER:** I was almost vomiting from fear. I was frightened to death. I was terrified, but I felt, 'If I do this, then I'm the most famous man in the world. I will get to Hollywood, I will have the nicest girls in the world, a Ferrari, everything.' I was convinced of that.

**SDM:** Well, you're in Hollywood now, and you have a Lamborghini and your beautiful wife beside you. Where did you go from there?

**KELLER:** I did a lot of development and research. I made some demonstrations for the U.S. Navy. Everybody said that I was just some sort of abnormal guy and that absolutely nobody else could do it, physiologically. So, I had to prove that it wasn't just me, that the method was good. So, I had a talk with *Life* Magazine. I met Ken MacLeish, a *Life* editor, in New York and I told him that I needed the story in *Life* to convince the U.S. Navy that a research contract with me would be a good idea.

MacLeish said, "Well, is it safe?" I said, "No, not at all; it is very dangerous. It is reasonably safe and we can do it, but there is a risk and I'm frightened." Then he said, "Now you talked me into doing it with you. Because you tell me you are frightened, that it is dangerous, I understand that you really know what you are doing. That convinces me that it is reasonable to go with you. I will come with you."

I told MacLeish that if *Life* paid me \$2000, I could do the dive and he would get the story. He bought a ticket to 700 feet and back, for \$2000, and within four weeks we constructed a new device. Ken MacLeish came and we trained him for three days and we went down to 728 feet. We made that deep dive without a chamber, without a bell. We had freezing regulators and had lots of problems. It was all right, but it was the limit for



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deep diving. That dive showed me that deep diving without a bell is too risky. I think that the 728 foot dive, without a chamber, is a world record which will remain for some time to come. It was crazy. One shouldn't do it again with that technology, but at that time nobody knew what deep diving really involved. If you realize that today one hour's work at 700 feet would cost approximately \$20,000 you'll see what I mean. The cheap deep diving method proved to be something impossible.

**SDM:** Then came your 1000 foot dive in 1962. The technical aspects of this feat has still kept the scientific community guessing, after all this time. Can you tell us about the gases you used, and something about the technique?

**KELLER:** Basically, we used a helium-oxygen mixture. About 97 percent helium and 3 percent oxygen. Going down we used different percentages of oxygen, nitrogen and helium, always working with the maximum of nitrogen up until extreme depths. After 600 feet I had practically no nitrogen, but up to 600 feet I used the maximum of nitrogen. I didn't do this for physiology, but for decompression. For a short dive, helium decompression is longer than for nitrogen decompression. You saturate faster.

**SDM:** Are commercial diving organizations such as COMEX and the U.S. Navy using a technique similar to yours, the formula you used to go to 1000 feet?

**KELLER:** Yes. My technique was to use helium in depth. Now that was nothing new, and there's actually no real alternative to that. Everybody is using that now. What I introduced was short decompression with a bottom time of, let's say, less than an hour at great depth. Buehlmann and I developed a new pattern for decompression, a new calculus, and we developed a trick of switching gas mixtures.

The trick was to switch at the given moment from helium to a heavy gas like nitrogen. Also, I did something which one did not understand then: it was a good thing that I was compressing with a lot of nitrogen in the mix. It has been discovered now that you can compress much more rapidly with nitrogen. Duke University sells it now as the big novelty. I was compressing very, very rapidly and it always worked out.

**SDM:** How fast did you actually go down?

**KELLER:** I simulated one dive in a chamber in Toulon, where I

went from 300 feet to 1000 feet in two minutes. That was as fast as I could make it. I had tremors and so on, but nothing to worry about. I had dizziness, but that is no problem. For saturation diving one doesn't need my technology. I think our breakthrough was that we proved short, deep dives were possible and could be done.

**SDM:** Were you not the first to try alternating gases, breathing different gases at different depths?

**KELLER:** Yes. That made decompression very rapid and also allowed me to compress rapidly, but you can do it with other techniques.

**SDM:** Such as the tri-mix methods they are experimenting with at Duke University? Have you heard that they have made a simulated 1000 foot dive, with a tri-mix of helium, oxygen and nitrogen? They have found that in deep dives nitrogen negates the tremors and nausea of helium, and that increased pressure negates the narcotic effects of nitrogen.

**KELLER:** I, and I think also my colleagues, don't know much about what the nitrogen does in the body. I think the studies are very hypothetical.

**SDM:** Hannes, here's the point: they're still trying, right now, to get to 1000 feet quickly, and with fast decompression, which you proved could be done in 1962.

**KELLER:** It is very funny how research is duplicated, and how people don't ask questions. The scientists usually want to cook in their own kitchens and they're not interested in the menus of others. They don't even copy you.

**SDM:** You are probably very well aware of the fact that after your 1000 foot dive a lot of people were yelling, "Hannes Keller is against science, against progress," because you wouldn't say what your 'secret' formula was.

**KELLER:** In 1964, Buehlmann and I published our method in the *Journal for Applied Physiology*. The reason we didn't publish it somewhere everybody would have easy access to it was because we didn't want these decompression schedules, which were purely experimental, copied. It was too close to the border of potential accidents. For example, I have calculated my 1000 foot decompression for five minutes bottom time. Now, if you stay eight minutes instead of the five minutes, then you need a decompression that takes at least twice the decompression time I had. Actually, three or four

times. And, if somebody now took my decompression tables from those experiments, the risk would be too much. Because of the accident we had to cut our bottom time by two minutes, from five minutes to three. We sent reports to five publications, to some doctors, the U.S. Navy, the Royal Navy, and other institutions. I'm sure Dr. MacInnis and other friends have it. To the scientists we always show what we have.

**SDM:** It seems significant that 12 years ago you accomplished this feat, and that today there is still not a working dive to that depth, which was actually 1020 feet according to the records.

**KELLER:** That is something I don't understand. If they would ask me, over the phone I would tell them how to do it. But nobody, over all these years, has ever asked me the questions, 'How did you do it?' 'Could we do it also?' If they would ask the question I would tell them immediately. I just don't run around to tell people, 'O.K., do it this way.' Before 1963 I was interested in having it myself because I was interested in financing my research, but the moment we had it financed by Shell Oil in 1963, there was no longer a necessity for secrets. Then it was published. Most people don't read scientific publications. There are few reading the *Journal of Applied Physiology*.

**SDM:** What do you think of the current state of commercial deep diving, in relation to what you did?

**KELLER:** The problem is naturally money and interest. Today, depth is no longer a problem. If COMEX decided to make a 2000 foot dive, a record dive in the ocean tomorrow, they could do it if they would be willing to pay the price for it. Depth, gas mixtures, and decompression are no longer a problem. Maybe such a dive would not be very efficient, but today you can do anything you want.

2000 feet would be a hell of a thing, but it's not only a question of money. Right now, there's no reason to do a 2000 foot dive because you cannot use it efficiently for practical work. In the past years we didn't have such a big offshore oil industry, so the oil companies were not terribly interested in depths. Now the situation has dramatically changed. There has been a tremendous boom, there's a lot of money going into offshore development, and deep diving will be developing very, very rapidly now. It's only a question of money; not a question of geniuses, pioneers.

**SDM:** At the time you were making your deep dives, or shortly after, you got very little support from the industry or from the U.S. Navy. Do you feel that what you have done has made the full circle?

**KELLER:** I think that I actually got a lot of support. Commandant Cousteau supported me in the very beginning. The Navy still thought it risky to support me. The industry was frightened to death to support me because they were wary of accidents. Cousteau did it I must say. He convinced the French Navy to have the chambers at my disposition and got some financial backing for the dives at Toulon.

For my deep dives, the U.S. Navy sponsored me and gave me the money I needed. My problem was not so much money, but developing the know-how. There were certainly conceptual errors in my 1000 foot dive. The biggest error was that I did not fill the chamber with helium. I had air in the chamber. Now, this was a question of money. I could have done it, I could have sold my car and put helium into the chamber, but my feeling was that I needed to demonstrate an economical way of doing a deep dive. If I had used helium the routine would have been expensive; people would have said, 'O.K., he can do it, but deep diving costs too much, it's not economical. It can't be used.' At the time I believed I needed to demonstrate an economical way of doing it. That was wrong. That was entirely wrong.

**SDM:** What are you doing now?

**KELLER:** Probably the rest of my life will always be the research and development of equipment for diving. There are a lot of things right now. After my deep diving, I received an R&D contract sponsored by Shell Oil in Europe, and I have

developed chamber technologies, a diving suit, etc. for them. After that contract was fulfilled I produced pressure chambers for hospitals, doctors and navies, and I have made the first portable two-man chamber which includes full climatizing.

It is a chamber with CO<sub>2</sub> filtering inside and without external ventilation. With a portable chamber you can't really ventilate because you'll run out of air. I installed a CO<sub>2</sub> filter inside which will function for several hours. But in a hot climate the humidity inside raises to 100 percent and the inside temperature with two guys in it raises something like 13 degrees F. above ambient. Now in hot climates, people would just die inside so I have made a portable cooling unit for that chamber.

This idea I sold about five years ago. I made a couple of chambers and delivered a deep diving system to various companies. Then I entered into a license agreement with Babcock, Germany, and they now produce chambers according to my ideas. Babcock is a very big company that makes atomic power stations, thermo power stations. They have 20,000 employees and now have an ocean technology department. In the heart of that department is the chamber program.

**SDM:** What else are you into?

**KELLER:** I have a consulting contract with Aqua Star for instruments, and I have just created a new decompression slide rule. It's a very little piece of plastic. It is meant to be used in addition to a normal decompression meter. I believe a sport diver needs a decompression meter before he buys an Aqua-Lung. It is a must. One should do some kind of decompression in every dive regardless of no decompression limits. But, decompression meters only tell you when you should start decompressing. So, for a preparation of a dive, you still need the tables. The tables are too difficult to handle, especially for repeated dives, and so the slide rule simplifies everything. It shows time, depths, five different types of decompression and surface times. It's very simple and safe and Aqua Star is putting them out.

**SDM:** Are you doing any further work with gas mixtures?

**KELLER:** I am doing a new kind of analysis of decompression tables. I have found a new formula to calculate mixed gas decompression and I think I have found a very, very good solution for it. The idea is that with a little table computer you can calculate any kind of mixed gas decompression. You

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"I'm not a scientist. Maybe I'm a charlatan, a very good charlatan, and a good charlatan in many different fields."



"... I would not be happy with just adventure, or just money-making, or just chasing girls, or just engineering things. I am the man looking for the right mix of all to get me into the depth of life..."





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**HANNES KELLER**  
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don't need the big computers anymore. This concept now goes into my new big deep diving system. At the end of 1975 my system will operate in the North Sea. For a consortium I make a saturation complex based on a ship with a bell, with a depth capability of 1500 feet. The system has cryogenic helium purification and full computer control. For safety this system has two computers working parallel, to control both: decompression plus operational procedures. I believe that we are making the most advanced deep diving capability.

**SDM:** Do you think sport divers will ever get into any sort of sophisticated gas equipment?

**KELLER:** No, I don't think so. I think what we have today with the compressed air system is something so simple that you can't really beat it. It's like the bicycle. You can't really improve the bicycle; you can change it a little bit, but it's still something that remains basically perfect, like shoes.

**SDM:** In London you gave a talk on diving in the year 2001, in which you expressed some rather far-out ideas about the future. What were some of these thoughts?

**KELLER:** Mainly I think the big problem is the diving suit. Today's wet suit is overly priced, stupid, bad, lousey material, lousey cuts, and it's not safe. If you run into the slightest problem, you are in trouble. Insulation is bad, everything is bad. I don't want to blame any maker of suits, but everybody makes them as they have always been made.

**SDM:** Are you talking just of the material — neoprene?

**KELLER:** The conception — from the material to the making of the suit. I believe in a dry suit, with buoyancy control, made out of some material which is resistant on the outside but which still has the excellent flexibility of neoprene. Something resistant and protective, but comfortable. Something to keep you dry, and in case you lose consciousness you can continue to breathe as long as there is air. But instead of sinking to the bottom, you float to the surface where you recover. If you have an accident, running out of air you can't worry about decompression, you have to get to the surface to be picked up.

**SDM:** If a diver is at neutral buoyancy and suddenly passes out, how is the suit going to bring him up?

**KELLER:** Glad you mentioned it. I have solved the problem. I have a prototype, a suit that brings a diver to the surface in such a situation. But it's not for publication. I have to complete the development, even though I am far advanced with it.

**SDM:** What will you use for a thermal insulator?

**HANNES KELLER**

**KELLER:** Because it's a dry suit, I would use a foam material, an open-cell foam material, not a closed-cell. Then it would not squeeze a bit, and it can be equalized. The outer surface would be very resistant and on the inside we would have some sort of a plastic material which is very soapy. Very easy to get in and out. The inside material is the most expensive material in my suit, but it is very comfortable. The outer material is already developed, too. It's a very flexible material, resistant, and you can make it metalized so that it looks like gold, or silver, or copper. It's fantastic.

**SDM:** Gold? That is fantastic! Do you foresee any changes in basic gear like fins, or a mask?

**KELLER:** Propulsion can be improved, at least. The moment we have a breakthrough with batteries, with power, then we might see a very small propulsion unit, something a diver can stick in his belt or connect to his back pack — something lightweight. One horsepower would be very good. A one horsepower unit you could make with roughly three pounds of weight, very small. But it's a question of the battery. Today the battery does not exist for this.

**SDM:** Hannes, what do you think about the state of diving technology? Do you think reasonable progress is being made in the development of most equipment, given the techniques we now have?

**KELLER:** Most technologies for the development of diving equipment are very, very primitive. When you look at this you won't see much equipment that is very convincing. When you develop a functional thinking, then you see many things that are not functional. For example, most of the diving gear is not designed by divers; it is designed on the drawing board. You can use it, but it is not good. For example: most firms are producing tanks which you are supposed to carry with a bent elbow. Crazy. You have to put the handle on the side. Then it is easy to carry. Now, somebody who has carried a tank knows this. Somebody at the drawing board wouldn't.

Also, life support for most submarines is not sufficient. You need at least six full days and nights life support for everybody. To do with less is crazy because to organize a rescue operation may well take six days. But within six days you can do everything in the world. If you don't have that time you may be unreachable.

**SDM:** Hannes, you have contributed much to the development of diving, and in many different areas. How do you see yourself in the overall scheme?

**KELLER:** I'm not a scientist. Maybe I'm a big charlatan, a very good charlatan, and a good charlatan in many different fields. Naturally, when I do something I try to be good and do a professional job, and al-