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2001: The Coming Age of Hydrogen Power

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Address to Pacific Area Senior Officer Logistics Seminar (PASOLS) on March 29, 1993, Hilton Hotel, Colombo. The audience included Adm. Larson, Commander-In-Chief of the Pacific Fleet, Lt. Gen. Stackpole of the Marines, and leading officers of the military forces from many other countries, including Australia, India, Japan, Korea, Russia, the Philippines, Sri Lanka, and others.)

Admiral Larson, Lieutenant General Stackpole, Major General Abayaratna, distinguished guests—I'm very happy to be here today, even though I should really be in Washington this week. On Thursday, all my friends there will be gathered in the Uptown Theatre to celebrate the 25th anniversary—I can't believe it!—of *2001: A Space Odyssey*.

Now, that movie provides a very good example of how difficult it is to predict the future. You may recall that in the film we showed the Bell System and PANAM; well, they've both gone, long before 2001. But I'm happy to see that the Hilton, which we also showed in 2001, is still here, though not yet in orbit!

This proves how impossible it is to predict social and political developments: who could have imagined what's happened in Europe during the last few years? However, we can, to some extent, anticipate *technological* developments by observing what's going on in science and engineering. But the problem there is predicting *when* things will happen, even though one can be quite certain that they will.

A good example is provided by my 1945 paper on communications satellites, which I imagined would be large, *manned* space-stations. When I wrote that, World War II was still in progress, and I was working on Ground Controlled Approach Radar, which had the then enormous number of something like a thousand vacuum tubes in it, at least one of which would blow everyday. So it was impossible to believe, back in 1945, that TV relay stations could operate without a staff of engineers changing tubes and checking circuits. But of course, the transistor and the solid state revolution came along within a few years, and what I'd assumed would have to be done by large manned stations could be achieved by satellites the size of oil drums. So everything I imagined would be done around the end of the century happened decades in advance.

Now, I'm going to say very little about communications satellites and the communications revolution, because you are all very familiar with what's happened here. Essentially anything we want to do in this area can now be done. And satellites have not only transformed

communications, but meteorology and navigation. You all know what the GPS (Global Positioning System) did during Desert Storm. However, the satellites I have always been particularly interested in are what I call “Peacesats”—the reconnaissance satellites which have been largely responsible for the Cold War never becoming a hot one, by creating a transparent world, and vastly reducing the threshold of uncertainty. But I won’t say any more about satellites, because (if I may be allowed a commercial) I’ve just written a whole book about them, *How the World Was One*.

So now I want to change the subject completely, to something perhaps even more important than the communications revolution. But first I’d like to mention a bit of forgotten history.

In December 1903, Orville and Wilbur staggered off the ground in North Carolina, and made the first controlled flight in a heavier-than-air machine. As a result, the North Carolina state motto is “First in Flight”—which you military men may well think a rather unfortunate choice of words.

Yet for five years, Washington didn’t believe that the Wright brothers had actually flown—because everybody *knew* it was impossible: leading scientists were still writing papers proving it couldn’t be done. Not until the Wrights went to France and started giving public demonstrations did the boys in the War Department say, “My goodness, these things really *can* fly. Perhaps they may even be useful for reconnaissance. We’d better look into it.” And they did—five years late. Well, history has just repeated itself, with what’s been (perhaps inaccurately) named “cold fusion.”¹

You all know, of course, that the Sun is powered by the fusion of hydrogen atoms, when they combine to make helium. Tremendous efforts have been made to reproduce this reaction on earth and produce virtually unlimited amounts of energy; the only successful attempt to do this so far is the hydrogen bomb. Literally billions of dollars have been spent in efforts to reach the multi-million degree temperatures in the heart of the Sun, where this reaction occurs. One day these experiments will succeed, but so far only a few percent of the input energy has been obtained, for very short periods of time.

However, just four years ago, two scientists named Pons and Fleischmann claimed to have achieved “cold fusion” *at room temperature* in certain metals saturated with deuterium, the heavy isotope of hydrogen. Under these conditions, they reported that they were getting out more energy than they put into the system. This, of course, created a worldwide sensation, and many laboratories tried to repeat the experiments. They all failed, and Pons and Fleischmann were laughed out of court. That was the last anyone heard of them for a couple of years.

But meanwhile, there had been an underground movement of scientists who believed that there might be something in all this business, and started experiments of their own—often in defiance of their employers. Pons and Fleischmann went to France just like the Wright Brothers—and are now working in a laboratory near Nice, financed by a Japanese consortium, Technova. Even more significant, Japan’s Ministry of Industry and International Trade (MITI) is investing millions of dollars in an effort to commercialize the new technology.

The laboratories of NTT—the Japanese telecommunications organization—recently announced positive results, and just before last Christmas, NTT started selling “Do-it-Yourself”

¹ Editor’s Note. For another look at this history see: Rothwell, J., *The Wright Brothers and Cold Fusion*. Infinite Energy, 1999. 2(9): p. 37, <http://lenr-canr.org/acrobat/RothwellJthewrightb.pdf>

Cold Fusion Kits for \$565,000 each. I don't know how many of them were snapped up, but that price sounds a bargain for a discovery that could change the world . . .

In October 1992, the Third International Cold Fusion Conference took place in Nagoya, Japan, and was attended by over 300 scientists. The highlights of the conference have been summarized in a 34-page report by Professor Peter Hagelstein, of MIT's Research Laboratory in Electronics. Other reports confirming positive results have been issued by the U.S. Navy Air Weapons Center, the U.S. Army Research Office in Japan, SRI International, and many others.

It is now beyond serious dispute that anomalous amounts of energy are being produced from hydrogen by some unknown reaction. The term "cold fusion"—"CF"—has stuck because no one can think of anything better. However, the skeptics who originally pooh-poohed the whole thing did have a very good point. If it really *was* fusion, the experimenters should be dead! Where were the neutrons and gamma rays and tritium and helium—the lethal "ashes" such a reaction should produce? Well, they have now been detected—but in quantities far too small to account for the energy liberated. The theoretical basis of CF is therefore still a major mystery—as was the energy produced by radioactivity and uranium fission when they were first discovered.

Now, what are the implications of this? I'd like to give several scenarios.

The first: there's a conspiracy of hundreds of scientists in dozens of countries. They're either totally incompetent—or they're superbly organized, and out to make a killing in oil and coal shares.

Slightly more probable: CF is a laboratory curiosity, of great theoretical interest but no practical importance. Frankly, I doubt this. Anything so novel indicates a breakthrough of some kind. The energy produced by the first uranium fission experiments was trivial, but everyone with any imagination knew what it would lead to.

The next scenario: CF can be scaled up to moderate levels—say 100-1000 kilowatts. Even that could be revolutionary, if cheap and safe units can be manufactured. It would make possible the completely self-contained home that Buckminster Fuller envisaged, because the electric grid would no longer be necessary for domestic distribution. And it would be the end of the gas-fueled car—none too soon . . . Automobiles could, quite literally, run on water—though perhaps only heavy water!

The third possibility is that there are no upper limits: in that case, the Age of Fossil Fuels has ended. So has the Age of CO₂ buildup, acid rain, and air pollution. Twenty years ago, when OPEC quadrupled oil prices, I remarked, "The age of cheap power is over—the age of *free* power is still fifty years ahead." I may have been slightly too pessimistic . . .

However, coal and oil will always be essential raw materials for an unlimited range of products—chemicals, plastics, even synthetic foods. Oil is much too valuable to burn: we should eat it.

Now please fasten your seat belts: after these modest daydreams, I want to really stretch your imaginations . . .

Back in 1982, I published *2010: Odyssey II* and dedicated it to my friend, Cosmonaut Alexei Leonov and to Academician Andrei Sakharov, then in exile in Gorky. I knew that Sakharov had worked on low-temperature nuclear fusion (as well as on the H-bomb!) and in the novel I

suggested that, in his enforced solitude, he'd invented a spaceship engine based on these principles. . .

He didn't, of course, so that's a piece of fictitious history. However, three Russian scientists who have indeed been working on nuclear propulsion for rockets have now got into the cold fusion act, and they have just published some startling results in *Physics Letters A*, one of the world's leading scientific journals. They are obtaining about five times their energy input in *gas mixtures*, not solids, and at temperatures of up to 1800°C. Now this is not exactly "cold" fusion, but it's certainly ice-cold compared with the tens of millions of degrees the hot fusioners are talking about.

And it's very interesting indeed from the point of view of rocket propulsion. If a plasma fusion rocket could be developed, it would open up the solar system, just as the airplane opened up this planet. It's not generally realized that the energy cost of going to the Moon is less than a hundred dollars in terms of kilowatt hours of electricity. The fact that the Apollo round tickets cost about two billion dollars per passenger is a measure of the chemically-fueled rocket's inefficiency.

Well, back to Earth. I'd like to read you a letter which I sent to Vice-President Al Gore last week; it should have reached him by now:

18 March 1993

Dear Mr. Gore,

COLD FUSION (?)

I am happy to learn that you are being briefed on the above—perhaps misnamed—subject, as it is impossible to imagine anything of greater potential importance from both the economic and geopolitical points of view.

After initial skepticism, I have now seen so many positive reports from highly respected organizations (*e.g.* NTT—which is already marketing experimental kits in Japan!—ONR, U.S. Army Research Office, SRI, MIT) that there can be no further doubt that excess energy is being produced by some previously unknown process, not essentially nuclear. I am sure that your staff has already seen much of this material, and I also refer you to Representative Swett's statement in the Congressional Record for 16 February, 1993.

Whatever the source of the energy, which I am sure will be elucidated in the fairly near future, the sixty-four trillion dollar question is: (1) is this merely a laboratory curiosity of no practical importance, or (2) can it be scaled up for industrial and perhaps even domestic use?

If Number (2) is correct, the consequences are immeasurable. It would mean essentially the end of the "Fossil Fuel Age" and an era of cheap, clean power. The environmental benefits would be overwhelming; at the very least, concern with CO₂ build-up and acid rain would vanish.

Clearly, no effort should be spared to resolve this matter speedily, by supporting scientists who are obtaining results (and, perhaps, discouraging those who have been obstructing them). One witness you might call is my friend, Dr. George Keyworth II, President Reagan's Science Advisor and an expert on fusion physics, who remarked in a recent letter to me: "The conventional path we've been pursuing is trying to build a bridge across the seas instead of inventing a boat." Perhaps "cold fusion" may give us the lifeboats Spaceship Earth so badly needs!

Respectfully,

Arthur C. Clarke

And as Stop Press, I should mention that Representative Dick Swett has just made the same point in a statement to the House Committee on Energy (26 March). Let's see if it produces more energy than went into it.

In conclusion: with monotonous regularity, all throughout history, religious crackpots have predicted the imminent end of the world. I have about 90% confidence that I'm now doing something very similar.

And this time, it's good news.

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