Japanese edition. And in their local Japanese page, they gave a big spread last spring to Takahashi. In the United States, in the English-language edition, it did not appear.

Gallagher: If these experiments are further developed, what are the technological possibilities?
White: Fleischmann and Pons are getting power densities of about 4 kilowatts (kW) per cm^3, which is on the same level as the breeder nuclear reactor. They're doing it for less than a half-hour; they don't have a prolonged burn. But the advantage of the cold fusion reaction appears that you get very little contamination, you get much, much more heat than neutron flux or tritium, which is what you want, because you don't want the tritium and you don't want the neutrons. The same things that make it a terrific scientific puzzle—why don't you get the radioactive contaminants?—is really a very big plus from the point of view of a realizable technology. So, they believe that they could make some form of boiler out of this, and therefore, that you could have small generators; and you could have localized power generation possibly. They see that as a potentially feasible thing in three, five, or ten years, that you would get some demonstration capability like that.

It's possible that it could also be used for desalination, but we haven't established that. It's simply the hope, that we would have this very controllable, very inexpensive generator; and you could have relative decentralization of your generation, so that you wouldn't have to have the overhead of the power-transmitting lines—you wouldn't have to transmit over such huge areas. Obviously, if we could do it, we could begin to use fusion power technologically for generation.

And, of course, if we can establish what's going on, then who knows what we could do? You don't really want to boil water and run a turbine to generate electricity; it would be much better if you could get positive and negative currents generated from the cells, so that you could capture it, and make your energy directly. But, whether that's a possibility, we're nowhere near that at this point.

But, you're just at the very beginning of a whole new branch of science, and we don't know what that's going to tell us. We don't know what it'll tell us about materials, and maybe many different things will come from it that we don't even consider today, just as with lasers or transistors, or any other new, unfolding branch.

Let me say that the implications of cold fusion are much bigger than superconducting, even high-temperature superconducting, or transistors, or semiconductors. If we can't unleash the energy of the nucleus in this safe way—

Gallagher: Such an easy way—
White: It's enormous. It's an enormous potential. Therefore, it's worth whatever the risk to see what's happening.

And if it turns out that this is some unique chemistry, or unique electronic effect that no one had known before, but not nuclear fusion, it's still going to be a tremendous discovery.

Gallagher: That brings up another question. Do the experimenters that you have interviewed and talked with and so forth, the public knows the name "cold fusion," but do they consider that they understand that this is fusion? Or are they still open to other explanations?
White: Well, there are many people with many different explanations: Some people feel that neutrons are travelling from the deuterium into the palladium, or into the lithium, and that you have a neutron transfer reaction, which is not a real fusion, but is a nuclear reaction.

There is undoubtedly an interaction between the lattice structure of the metal, the crystal lattice structure and its vibrations, and the implanted deuterium atoms.

Gallagher: Can you explain? You have a metal lattice and its vibrations. What metal are you talking about?
White: Palladium.

Every metal has a structure; it's a solid, and that solid structure vibrates and has a kind of vibrational motion. There are many theories that suggest that that creates a climate favorable to allow fusion to take place, even though you would not normally think that it could occur.

Gallagher: It's vibrating under conditions where it is the negative pole?

Cold fusion, courage, and a passion for truth

In September 1992, 21st Century *editor Carol White interviewed Martin Fleischmann and Giuliano Preparata in southern France. The following is excerpted from that interview in the Winter 1992 issue of* 21st Century.

Fleischmann . . . remarked rather wryly on the moral predicament that his and Stanley Pons's discovery of this extraordinary phenomenon had created for them. "If this had just been some normal science and I had so much flak thrown at me, I might well have given it up," he said. "It just was not worthwhile to take that amount of abuse. But this is not a normal piece of science. If it turns out to be useful, it will be of such consequence that it cannot be regarded as normal science. Therefore, it brings in its train the antagonism, and the political element, and all of the other factors that have so bedeviled us. But Stan Pons and I decided that we could not back down, that to do so would be irresponsible."

Preparata interrupted to underscore the importance of courage to a scientist—to be willing to stand up for the

White: Well, no. Inside the palladium, which is the negative electrode, is where you would be getting some kind of an oscillation, which would encourage the possibility of the deuterium to be accelerated and fused together; so, you get some form of collective interaction of the host metal, the palladium, which creates electron clouds and somehow accelerates these nuclei of hydrogen, the deuterium nuclei, in such a way that they can come together and mesh. Or maybe, they're in clusters and they come together in some geometrical way to actually have a nuclear interaction.

But what that nuclear interaction is, is a very big question, and there are many different theories of that.

Gallagher: You are talking about a context in which deuterium—this is a gas—is getting inside a metal—palladium—and apparently a great deal of the deuterium is getting inside the metal. Is that unique? In other words, the absorption of a large amount of gas into a metal, is this a field of chemistry? Is this unique to these materials? Or is this something these people were working on before that?

White: People were working on the absorption of deuterium in palladium, for example, to build detectors for nuclear reactors. Also, palladium can simply be used to store hydrogen. Working with deuterium in palladium is something that people have done for other reasons; it wasn't something unique to the experiment. The study of hydrogen and its flow in palladium has gone on since the 1920s, and there are many people who worked on that: Paneth, Alfred Coen in Germany, and there have been many studies of that.

Gallagher: And is it this which makes the cold fusion occur? this packing of the deuterium inside this? is this what leads to excess heat, and so forth?

White: I believe so. I believe that what actually occurs is that, in the surface of the palladium is where the activity happens, or at least, where a lot of the activity goes on in a surface layer, or near-surface layer, where you get very dense concentrations. And it's in these dense concentrations that the initial fusion is, at least, or the initial nuclear reactions, take place. Then, you may have diffusion into the center of the volume of the palladium, or—it's not really clear what's occurring.

Gallagher: There have been reports of explosions of one or two of these experiments. Are they characterized by very rapidly increasing amounts of energy and heat?

White: There was one. You're talking about the explosion that killed Dr. Andrew Riley on Jan. 2, at SRI last year. But it was not a mini-bomb explosion. Possibly, you got a lot of excess heat from fusion taking place, but the explosion

truth no matter what the opposition. He pointed to the situation of Pons, who had been the chairman of the Chemistry Department at the University of Utah, but had his tenure removed after the attacks on him and Fleischmann from the press and the majority of the scientific community.

Laughing, Fleischmann responded: "Yes, that is perfectly true that Stan and I were courageous, but I did have the good sense to make the announcement about cold fusion after I had retired. I had no illusions about the kind of attack we would face. Stanley Pons and I discussed the kind of problems that could emerge, and I asked him, 'Stan, are you really sure at this stage in your career that you can take this on, because it is going to be bad,' and he said, 'yes.' "

Fleischmann described Stanley Pons as a man of absolute integrity, willing to pursue and fight for the truth at all costs. . . .

Preparata emphasized in this regard that the approach that he and Fleischmann were adopting was, in fact, the Platonic method of hypothesis. One must have the courage to ask "why?" not just "how?" For Aristotle and his followers, it was enough to ask how.

Fleischmann agreed, pointing out that this method, posing "how" rather than "why," always leads to a complicated patchwork in which an incorrect theory is "fixed up" rather than discarded and replaced by a more truthful, more comprehensive theory. He stated, "In the end you always have to go back to Plato, and really this is how science most efficiently answers the question of 'how,' by understanding 'why.' The universe is governed by reason and simplicity. If we think it is complicated, almost certainly we are wrong.". . .

In other words, the question of "why or what if" leads in the final analysis to the most fundamental questions of the creation, the possibility of the very existence of the universe as we know it. If it were not for constants such as the fine structure constant and the speed of light, then our universe would not exist.

For Preparata, this is a question of God's generosity to man in allowing man to understand how reason governs nature. "It is an act of generosity toward man," he said, "to make him understand. I am a religious person and according to my metaphysics, the ability to understand nature is a great gift to us."

Fleischmann concurred. . . . "I believe that the moral sense must be ingrown. . . . It has to be in there. I see it as a total part of the universe. In this it is like a scientific idea. The universe is there for us to discover, and the moral principles are there for us to discover. . . .'