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# Comparisons from the History of Technology

## Can an unpopular scientific discovery be forgotten?

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Earlier today Ed Storms said, "cold fusion is on life-support." Will it survive? Can an unpopular scientific discovery be forgotten? Ed thinks that cold fusion is endangered. In a lecture titled "Cold Fusion – Does It Have a Future?" [1] Nobel Laureate Julian Schwinger said that science itself is at risk:

> The pressure for conformity is enormous. I have experienced it in editors' rejection of submitted papers, based on venomous criticism of anonymous referees. The replacement of impartial reviewing by censorship will be the death of science.

Martin Fleischmann says that society does not want science anymore. People will not accept innovation; it is too disruptive. Thomas Jefferson warned that the entrenched establishment opposes research, education and progress because they are disruptive. True progress is revolutionary:

> . . . And how much more encouraging to the achievements of science and improvement is this, than the desponding view that the condition of man cannot be ameliorated, that what has been must ever be, and that to secure ourselves where we are, we must tread with awful reverence in the footsteps of our fathers. This doctrine is the genuine fruit of the alliance between Church and State; the tenants of which, finding themselves but too well in their present condition, oppose all advances which might unmask their usurpations, and monopolies of honors, wealth, and power, and fear every change, as endangering the comforts they now hold. [2]

Some people say progress has stopped. Popular books claim we have reached the end of history, science is close to perfection, there are no more great discoveries waiting to be made, and no more worlds to conquer. John Horgan, a *Scientific American* columnist, wrote a book titled *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*. It sounds like a Dave Barry parody, but Horgan means it! These people say that manned space exploration was a bust. We are stuck on earth forever. They say the poor will always be with us, and though we might ameliorate pollution we can never reduce it radically, a thousand-fold. We will muddle through in a future much like the present.

I agree with Jefferson, who said that scientific knowledge will increase "not *infinitely*, as some have said, but *indefinitely*, and to a term which no one can fix and foresee." [3] We reached the moon only a generation ago; it is too early to turn our backs on the cosmos. Cold fusion together with other new technologies can eliminate air and water pollution, and they can do

much, much more. People do not realize how revolutionary cold fusion is. Let me give two examples to put you in the right frame of mind, so you will see why we must work to preserve this discovery. Cold fusion can give us more land, and more food.

More land, because it will let us move our industrial plant to the deserts, or underground, or even to the moon if we like. And because we can replace most of our highway traffic with automated air transport. You might wonder how cheap energy can reduce highway traffic. Well, air freight is expensive mainly because of fuel. Cold fusion will make airplanes nearly as cheap as long distance trucks, and new air traffic control computers will allow more flights, so together they will take most trucks off the highways. That's why I say "cold fusion together with other new technologies" will work with synergy. Today, our highways cover an area the size of Maryland with an asphalt desert. They cost as much as a small war, with similar casualty rates. We do not have to live with blight and carnage. We can take back most of the land sacrificed to highways – much of it prime real estate – and build houses on it, or return it to nature.

How will cold fusion produce food? Today, most of the cut flowers sold in London, New York and Tokyo are grown in gigantic indoor farms in Holland. [4] In Massachusetts, an automated, one-acre enclosed fish farm in an industrial park produces a million pounds of trout a year. [5] Someday, with cold fusion light and heat, all of our food may be grown in multilevel indoor farms. We could concentrate the farms in an area the size of New York City and grow enough food for every man, woman and child on earth.

Cold fusion will eliminate most pollution. Eventually, we will make the air and water as clean as it was before the industrial revolution.

The changes I have described will be monumental. They will absorb mankind's creative energy for generations, and give our lives a noble, generous, yet practical and rewarding purpose, something sorely lacking in this self-indulgent age. The transformation may take a century, or longer. Skeptics say it cannot be done. They say we can only hope to muddle through to a future marginally, incrementally better than what we have today. To them I say: open your eyes and look around. Look at the railways, the highways, the great cities, the power and telephone networks. Our parents and grandparents remade the face of the earth and revolutionized our way of life. They did not settle for incremental improvements. In the space of a lifetime they wiped out most deadly infectious diseases. They went from Kitty Hawk to jets that fly halfway around the world at 900 kilometers per hour carrying 400 passengers. They cut down the vast forests of North America that once allowed a squirrel to travel from Florida to the Great Lakes jumping from branch to branch without ever touching the ground. They bulldozed half the continent. We too can remake the face of the earth. We'll grow the forests back. We can do a better job than our grandparents did by learning from their mistakes, and by using powerful tools like cold fusion and computers. We are not running out of resources. The bounty of the whole solar system is open to us. As Franklin Roosevelt said, "plenty is at our doorstep, but a generous use of it languishes in the very sight of the supply." [6] We are not running out of land, or food, or energy, or any natural resource – the only things we are running out of are intelligence and gumption.

## *Three discoveries lost and found: genetics, photography, superconductivity*

Let me get back to the question: Are we really in danger of forgetting cold fusion? Do people ever forget physics? I think cold fusion is vulnerable, because it is not technology yet. It is still science, or proto-science, or you might say it is an uncontrolled laboratory curiosity. We hope to make it into technology. Once people find a practical use for it, survival is assured. A naturalist wanting to preserve an endangered species recently suggested we should raise the animal for human consumption, since people will never let a useful domesticated animal go extinct.

Here are three well-known examples of science that was lost and found: Mendel's genetics, photography, and superconductivity.

Gregor Mendel's papers on genetics were published in 1866, but they were ignored and forgotten. The principles were rediscovered independently by three botanists, who searched the literature, found Mendel's papers, and made them famous after 34 years in obscurity. This discovery was truly lost.

Photography wasn't forgotten, but it languished for a century. In 1727 German chemist J. H. Schultze made the first shadow picture of stenciled letters, and proved that light, not heat, caused silver nitrate to darken. Primitive photographs were formed in 1777, and in 1802 Thomas Wedgewood made the first good quality photograph, but he was not able to "fix" the image. The image would appear gradually, grow darker, and then fade into black. Only the photographer would see it. Daguerre found a way fix the images in 1829, and he finally got around to telling people about it ten years later in 1839. As you might expect, another scientist jumped in and claimed priority. At last photographs could be preserved, and passed around in the light of day for people to see. When the news hit, photography was a sensation, but it was also widely denounced as a fraud. A Leipzig newspaper denounced it as an affront to German science and God. [7] The public was surprised by photography, yet people should have known it was coming, because it took such a long time, with slow, step-by-step development. People did not hear about photography because it was a laboratory curiosity. It was literally hidden away in the darkroom. The history of photography provides a perfect illustration of why a demonstration of new technology is so vital.

Superconductivity was discovered in 1911. It languished with no technological application until the mid 1960s when the Josephson effect (1962) was used to make high-sensitivity measurements of currents, voltages, and magnetic fields. High temperature superconductivity was discovered in 1986 but so far it has only been used to replace low temperature devices in established applications. The basic discovery was never forgotten, but it has been marginalized. A businessman might call it a "zombie product" – one that never sells enough to pay but never quite dies either. I think this is the most likely outcome for cold fusion, unless we can turn the situation around.

Many other important discoveries were overlooked, denigrated or ignored. Have any been lost altogether? There is no telling. It is like the old joke: "raise your hand if you are absent." Some people argue that science automatically preserves everything of value. If that is true

scientists are unique. People in other professions constantly misplace important contributions. Great works of art and literature have been lost. Movies are only a century old but already some classics have been lost. Believe it or not, simple programming techniques that were common a generation ago have been unlearned, or temporarily lost. A Windows utility I tested recently took a half-hour to execute. I replaced it with an old-fashioned batch process that runs in two minutes. A letter in Byte magazine said, "as much as I enjoy my PCs, I often have the impression that they and their operating systems were designed by young people who somehow missed out on the entire history of computing technology . . ." [8] In engineering, ideas are constantly lost and found. The staff at the University of Manchester built a one-third scale working replica of a 1712 Newcomen steam engine. They gained new respect for Newcomen's original genius. They wrote, "the true functions of the key components were fully understood and their relationship to the operation of the engine appreciated." [9] You might think the first steam engine was simple, but we forgot how it works. I doubt that scientists are better at preserving information than librarians, movie archivists, programmers or engineers, so I suppose important scientific breakthroughs have been lost. Martin Fleischmann says we should comb the back issues of *Nature* for great overlooked ideas.

It may be that science was better at sifting and preserving good ideas in the 19th century, when people started with a clean slate. Every discovery was important, valuable, and easy to understand. Ideas did not compete with an existing canon, because there wasn't much of a canon. Thermodynamics easily pushed aside the caloric theory. Most discoveries quickly led to practical applications. X-rays were put to use in medicine within weeks of Roentgen's announcement. Nowadays, new ideas must compete with viable old ideas, so the new ones may die, or be delayed. NMR is not as compelling as it would be if we did not already have x-rays. Perhaps this is why NMR inventor Raymond Damadian spent years battling establishment skeptics and struggling to find research funding. [10] Damadian ascribed sinister motives to his opponents. He thought cancer researchers actively opposed development because the NMR may reduce cancer and hurt their livelihood. (See footnote.) I do not know the facts of the matter, but this sounds unrealistic and lurid. It seems more likely the X-ray gave the experts the luxury of ignoring the NMR. They did not appreciate how much better the NMR would be for some purposes. People think of cold fusion as another form of nuclear energy, along with fission and hot fusion. They compare it to other pollution-free, zero-fuel energy sources like solar, geothermal, wind or hydroelectric. These alternatives make the development of cold fusion seem less urgent.

People overlook ideas because they are satisfied with the technology we already have, and satisfaction is the enemy of progress. The newspapers say we are living in an age of unprecedented progress. I think we are in the doldrums. Chris Tinsley used to say that every important technology except the laser was invented before 1950: jet engines, computers, semiconductors, antibiotics, nuclear energy . . . We have been living off the intellectual capital of the past. Personal computer architecture has not changed in 18 years. It was obsolete when it was introduced in 1981, with two serial ports, 640 KB addressability, and ersatz multitasking. We made the PC our standard, we have not changed it, and that decision has cost society billions of dollars in lost productivity and lousy software. Admiral Grace Hopper was a software pioneer and the lead designer of COBOL. During an interview shortly before she died, she listed some innovations she was thinking about. Her ideas would have revolutionized software far more than

minor add-on improvements like Microsoft Windows, which programmers call 'window dressing,' 'DOS with a bag on it,' and which the *New York Times* called, "an edifice built of bailing wire, chewing gum and prayer." [11] We have become inured to unimaginative, slow, unreliable software and other third-rate consumer goods. We should demand more. Critics say Americans are too self-centered and too demanding. I am glad they are demanding. Software will improve when consumers demand it. Cold fusion will be developed when consumers demand it.

## *The generational role reversal, and why old coots are today's Young Turks*

One of reasons we go into this mess is what I call 'the generational role reversal' or, why old coots are as today's Young Turks. Max Planck said:

> A new scientific truth does not triumph by convincing its opponents and making them been in see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it. [12]

But cold fusion was discovered and confirmed by old scientists and it is attacked by young scientists. I fear the opposite of Planck's progress: a new scientific truth will die as its proponents eventually die, and a new generation will grow up that never heard about it. McKubre said in his closing remarks at ICCF-7:

> As our average age increases with each ICCF, as the rate of progress isn't as fast as it could be, we will just <u>die</u> before we understand this. Our critics will succeed not for any good reason but because we have lost the capacity to stand up at a microphone and speak.

Historically, young scientists have made most new discoveries. They outlived crotchety old naysayers and triumphed in the end. Young scientists were encouraged to think independently and try new ideas. When they failed, no one held it against them. Young people are better equipped to do ground breaking research because they have more energy. They are blessed by ignorance in a sense: they do not realize how difficult the problem is, so they boldly solve it. They are not encumbered by knowledge of present techniques, so they invent new techniques. They have the instinct to explore, and strike out for new territory. This is considered the natural order of things, and perhaps it is, but it is also a cultural construct. Unfortunately, the culture of science has changed. We punish failure. Research is too formal. Fun in the laboratory is discouraged. Young people have grown up with this system and know no other. Nowadays, old scientists are in the vanguard. They have tenure. They came of age in a more dynamic, liberal era when mistakes and adventures were encouraged, and progress was in full flood. Young scientists are afraid to step out of line. Controversial research will jeopardize their careers. Too much scientific funding is controlled by policymakers in Washington and science journal editors who demand allegiance to established theory. (If I may be permitted a political aside, I see this as a symptom of our politically correct, conformist era, which is also characterized by neo-Victorian, hypocritical, holier-than-thou sexual morality, censorship, and invasion of privacy by government snoops.)

Not only in science, but also elsewhere in society the traditional roles of the generations have been reversed. In politics, people over 65 are the free thinking, open-minded liberals. They are the subversives who say Why not? Why can't we change things? The Great Depression and Second World War taught them the world can change overnight and monumental tasks can be accomplished quickly. Freeman Dyson wrote, " . . . [The] experiences of World War II made an indelible impression on people of my generation. At the bottom of our hearts we still believe you can have anything you want in five years if you need it badly enough and if you are prepared to slog your way through the barriers of confusion and incompetence to get it . . . The accepted wisdom says that, no matter what we decide to do about economic problems, we cannot expect to see any substantial results [for 15 years]. The accepted wisdom is no doubt correct, if we continue to play the game by the rules of today. But anyone who lived through World War II knows that the rules can be changed very fast when the necessity arises." [13] Our job is to convince people that the necessity for change has arisen, and the means are at hand.

## *Why We Need a Demonstration Device*

To summarize: we face apathy, loss of faith in the future, establishment opposition, and generational role reversal. These problems would not matter if cold fusion were easy to replicate. But it is hard to replicate, which that puts us in a pickle. Gene Mallove and I think that the only way out of this predicament is to make a demonstration device, to convince the public. We need a proof-of-principle demonstration, that is, a miniature version that shows the thing can be done. It could be a jury-rigged prototype. It does not have to be practical. Investors must be wooed first; the scientists will follow. Traditional academic methods of persuasion, such as peer-reviewed journal articles, have been tried and found wanting. If cold fusion had been judged according to the rules, the debate would have been settled nine years ago when Fritz Will and Mike McKubre published. Gene and I tell scientists to put aside their theories, stop trying to improve their calorimeters, stop trying to improve reproducibility for the time being, and concentrate on a public demonstration instead. A demonstration should be installed near a big city so that investors and scientists can come have a look. We think our laboratory in Bow would be the ideal location!

Many scientists respond to our suggestions with hostility, because they do not understand our strategy. They think we are denigrating theory, and belittling the need for rigorous experiments and better calorimeters. We say first things first: get the funding, and then go back to your research. Many scientists dismiss this as grandstanding or a publicity stunt. It is a stunt, and we need stunts! We favor science by press conference.

When Edison was developing the incandescent light, he hung lights outside the Menlo Park laboratory and turned them on every evening. People came from miles around to see. Extra evening trains from New York had to be scheduled to accommodate the crowds. This did not stop the inevitable attacks by the establishment. A distinguished professor called the light bulb "a conspicuous failure, trumpeted as a wonderful success. A fraud upon the public." The *Scientific American* published a letter saying it would be, "almost a public calamity if Mr. Edison should employ his great talent on such a puerility." [14] Edison did not sway the establishment at first, but he enlisted broad public support. The hot fusion scientists attacked Pons and Fleischmann for

doing “science by press conference” but they themselves depend upon press conferences to impress the Congress and sway public opinion. The cold fusion press conferences in 1989 were a good idea. We should have held more press conferences; SRI should hold one today. They should boldly declare they have confirmed cold fusion.

## *Science and stock markets, the cyclical nature of history*

The generational role reversal is one reason we got into this mess. Another is that science happens to be at a low ebb. It is going through a conservative, uncreative phase in which theory overrules experiments, talented young people ignore science, and experts go around saying this is the twilight of the scientific age. I think science is cyclical, like the stock market. An upsurge begins when a dramatic improvement comes along. Success follows success; excitement causes more excitement. Society rewards the enterprise with bigger budgets, more money. Eventually the process gets out of hand. Too much success carries the seeds of future failure, breeding smug satisfaction, hubris, bloated budgets in science, and irrational exuberance in the stock market. Giant projects like the hot fusion program and the supercollider are botched; the public loses faith, budgets are cut, morale plunges. We reach a low ebb, a crisis. The crisis leads to self-examination, house cleaning, renewal and revitalization, and the cycle begins again.

Our job is to trigger this revitalization by convincing the public that cold fusion is real. The public will demand that scientists investigate cold fusion. R&D budgets will be allocated, and then the physicists will say they believed it all along. Stanislaw Szpak, a cynical cold fusion researcher in the Naval Research Lab, says, “Scientists believe whatever you pay them to believe.” The revelations of cold fusion will rejuvenate the rest of physics when people realize the experts are wrong and we do not know everything after all.

I hope we succeed in my lifetime. Regardless, I have faith that science will recover, and mankind’s adventures will begin anew. The earth will be healed, and the marvelous bounty I envision – food for everyone, the resources of the whole solar system – will be ours. Science is at a low ebb, but it will recover. We will again see the kind of dynamic era Walter Lord described in his history of the years between 1900 and 1914. I would like to close with a quote from his book:

> The spirit of an era can’t be blocked out and measured, but it is there nonetheless. And in these brief, buoyant years it was a spark that somehow gave extra promise to life. By the light of this spark, men and women saw themselves as heroes shaping the world, rather than victims struggling through it.
>
> Actually, this was nothing unique. People had seen the spark before, would surely do so again. For it can never die as long as men breathe. But sometimes it burns low, leaving men uncertain in the shadows; other times it glows bright, catching the eye with breath-taking visions of the future. [15]

## Footnotes

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6. Kita, R., Frontier Perspective, Fall 1998, Vol. 7, Num. 2, Book Review of "A Machine Called Indomitable," by Sonny Kilenfield, Times Books (Random House, 1986). Kita writes: "In regard to those who opposed the development of his diagnostic machine Damadian said, 'The second force besides the established NMR community was the cancer establishment.' Damadian notes that they simply didn't want this machine to be available since it might help to eradicate the disease. Richard Nixon put one billion dollars into cancer research for three years, but the only return on this expensive research was that the cancer rate continued to climb. The vested interests in this business are decades-deep. The sad truth is that more people are living from cancer than dying from it."

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