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NEWS AND COMMENT

Nuclear Weapons History: Japan's Wartime Bomb Projects Revealed

A little-publicized chapter in the history of atomic weapons is the Japanese effort to develop an atomic bomb during World War II. The effort centered around Japan's university physics laboratories, and its chief figure was Yoshio Nishina, who was Japan's leading scientist and a physicist of international stature.

Although the effort was unsuccessful—and was probably doomed from the start because of lack of manpower, funds, uranium, and the disorganization of its military sponsors—the project is highly significant to the history of nuclear weapons, to Japan's subsequent self-denial of nuclear weapons, and to the relationship that developed between Japan and the United States after the U.S. atomic bombing of the cities of Hiroshima and Nagasaki in August 1945 (see inserts).

In addition, the Japanese "Manhattan Project"—such as it was—may have been the reason for the destruction of Japan's five cyclotrons and the dumping of them in Tokyo Bay by U.S. occupation forces in November 1945.

Because of its alleged mindlessness, the destruction caused an international protest and was denounced by U.S. scientists. It played a role in the battle then being waged in Congress for civilian control of atomic energy.

Much has been written about how the United States and Britain during the war were concerned that the Germans, who had discovered atomic fission in the 1930's, would develop the world's first superbomb based on this principle. The story has often been told of the heroic attempts by the Allies to destroy heavy water production at the Norwegian plant at Vemork, from which the Germans were demanding increased production, clearly destined for their atomic research. One of the most extraordinary scientific intelligence missions in history was the Alsos mission, in which an internationally prominent physicist, Samuel A. Goudsmit, was put in charge of a team of specialists that accompanied the Allied armies into Germany, seized uranium stocks and equipment, and interviewed the German scientists about how far they had gotten. Indeed, the German wartime atomic research effort—which was known through such clues as the Vemork plant's activity—was a major rationale for the Manhattan Project in the United States.

But in the case of Japan, the United States appears to have known very little—and knows very little to this day—about the fact that the Japanese scientists were also ordered to do whatever they could to develop an atomic bomb. As authoritative a source as General Leslie R. Groves, the chief of the Manhattan Project, devotes only a single paragraph of his memoirs to the issue. Groves writes that he never took the possibility of a Japanese atomic bomb seriously because of Japan's want of enough scientists, uranium, and industrial backup capacity. But he admitted that, "It would have been extremely difficult for us to secure and get out of Japan any information of the type we needed." In other words, he had far less intelligence about Japan than he had about Germany.

Indeed, with the single exception of the period before the November 1945 cyclotron incident, it seems that no one in the U.S. government took the possibility

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of a Japanese atomic bomb project seriously.

Still more curious is the curtain of silence which the Japanese themselves seem to have pulled over the subject, and which they have kept tightly drawn since the war. An extensive search through records of American intelligence missions conducted in Japan at the end of the war shows that even the Americans who interrogated Nishina concluded that Japan had had no atomic bomb project—a direct contradiction of Japanese historical materials that have since come to light.

Why the silence? Were the Japanese afraid of being arrested as war criminals, as the chief of Nishina's laboratory had been? Were they silent in horror of the consequences of the work, which they had observed firsthand at Hiroshima? Even today in Japan, when historians tell Japanese that there was such a project, many Japanese react with disbelief. Japan's postwar official policy, that she does not and never will seek to be a nuclear-armed country, seems to have inhibited discussion of the project. Japan's wartime atomic research, in Japan, has become a social secret.

The documentation of the effort is contained in two authoritative Japanese histories. One is a history of science and technology in Japan, of which volume 13, published in 1970, deals with science and technology during World War II. A second source is a social history of science, by Tetu Hirosige, published in 1973, that has an entire chapter devoted to the wartime science mobilization, including among other things, atomic research. Nishina died in 1951 and there is no known account by him of his wartime activities. But there are other firsthand accounts, notably the diary of Masa Takeuchi, a worker at Nishina's laboratory who was assigned to the thermal diffusion project, and a memoir of Bunsabe Arakatsu, a physicist from Kyoto.

These materials have been collected independently by two scholars in this country, Herbert F. York, Jr., director of the Program in Science, Technology, and Public Affairs at the University of California at San Diego, and Charles Weiner, professor of history of science at the Massachusetts Institute of Technology (M.I.T.). Weiner is now completing a full-scale historical study of the subject. Both York and Weiner generously lent their materials to *Science* for the preparation of this article. In addition *Science* obtained materials from the National Archives regarding U.S. intelligence about Japan at the end of the war.

In the context of 20th-century physics, it is no surprise that physicists in Japan were tempted, around 1940, to study the military applications of fission. Throughout the 1930's, Japan had kept pace with the exciting developments in physics—with theory in Europe and experimental techniques in the United States. Weiner has written about how close Japan was to the work in Europe and the United States: Nishina spent several years in Copenhagen in the laboratory of Niels Bohr, where, ironically, Samuel Goudsmit recalls having suggested to him an experimental apparatus based on a mechanism found in his niece's toy horse.

Goudsmit, in an interview with *Science*, recalled that the Nishina of Copenhagen in the 1930's was a very cosmopolitan man, who spoke good English, and who bore his stature as Japan's preeminent scientist with ease.

In the 1930's, too, the Japanese also became schooled in the techniques of the cyclotron, through a small machine built at the Riken, Nishina's laboratory in Tokyo, and by sending a much younger physicist, Ryokichi Sagane, to Berkeley to work under E. O. Lawrence. Sagane, an outgoing, affable figure, struck up friendships with Lawrence and other American physicists and traveled widely in Europe. Lawrence also arranged for the contribution of a 200-ton magnet for a second cyclotron at the Riken. The cyclotron, which was to be 60 inches in diameter, was planned to be the largest one in the world in 1937 when construction began. But it was not finished until 8 years later, shortly before the war's end.

This 60-inch cyclotron—which was as much an emblem of national scientific stature as the giant accelerators are today—is as much a player in the drama of Japan's wartime atomic research as any of the scientists or officials. The big machine was clearly Nishina's pride and joy. According to one account, after his laboratory had been bombed nearly to ruins, and after he had visited Hiroshima, Nishina's first words on reentering the lab were, "Is the cyclotron working?" By some miracle it escaped the war unharmed only to be jettisoned by the U.S. Army in November 1945. But this gets ahead of the story.

While Japanese physics at the outset of the war was strong enough to carry researchers naturally into the problem of the fission weapon, it was "too brittle," in the words of social historian Hirosige, to bring the project to a successful conclusion. Nishina, Sagane, and some others were clearly world class physicists; but the historian notes that Japanese physics included a "comparatively large number of nonadvanced fields." This brittleness was to take its toll.

Scientists Suggest Project

The scientists themselves initiated atomic bomb research in September 1940, when, Hirosige says, "Nishina started considerations for the possibility by the commitment from the Sixth Technical Institute of the Army. . . ." Army sponsorship was arranged, and "fairly large-scale research" began at the Riken "from December, 1940." Takeuchi's diary says that this work was devoted largely to measuring the fission cross section of uranium, although he does not say what value was arrived at.

The years 1940 and 1941 were a period of intense military interest in the possibilities of atomic weapons. In 1941, Prime Minister and War Minister Hideki Tojo ordered 31-year-old Takeo Yasuda, a rising young army air officer, who was then chief of the Army Air Technical Laboratories, to investigate the possibilities for a fission weapon, and Yasuda passed the order on to the Riken.

But in the first of what was to be a series of uncoordinated orders to the scientists, the Navy also engaged the Riken's services, and launched an inquiry into the feasibility of the weapon in late 1942. This led to the "Physics Colloquium," a galaxy of Japan's leading scientists who met for ten sessions between December 1942 and March 1943, to investigate the feasibility of Japan's achieving a weapon.

Derek de Solla Price, Avalon Professor of the History of Science at Yale, with Eri Yagi Shizume, a Yale graduate student, investigated Japan's wartime atomic bomb effort and published a letter in the Bulletin of the Atomic Scientists *in 1962, seeking more information on the project. But none was forthcoming. Price believes the effort was serious enough to "change the moral and ethical relationship between Japan and the United States."*

Japan's attempt to acquire an atomic weapon during the World War II changes the moral and ethical relationship between Japan and the United States that has grown up over the use of the atomic bomb against Japan. The story has been that the Americans were guilty and the Japanese were innocent and blameless; that the Americans developed this terrible new weapon and proceeded to commit an atomic rape of the then-helpless Japanese.

But the fact that the Japanese were trying to develop the bomb, too, means that America was in an arms race with Japan as much as she was with Germany.

The accounts do not detail the Colloquium's investigation, whether it examined Japan's industrial capacity, her access to uranium through her new Asian conquests, or the other practical problems. Takeuchi's diary says that by March of 1943 Nishina was thinking in terms of processing "hundreds of tons" of uranium. Still another account, in the science and technology history, indicates that the project would require one-tenth of Japan's annual electric power consumption and half of the copper required for Japan's military forces. But whether these estimates grew out of the Colloquium, or were made at some other time, is not known.

But the fragile nature of Japanese science asserted itself during the Colloquium, and obviously hindered the inquiry. Hirosige writes:

> There even happened a poor and rude scene that the "leading figure," Hantaro Nagaoka (the author of the Nagaoka atomic model) once proposed to survey Burma by the reasoning that uranium is heavy and would concentrate in the wrinkles of the earth's crust, and the proposal was readily accepted by the "colloquium."

The Colloquium's conclusion, relayed to the Navy in March 1943, was that an atomic bomb would be impossible "even" for the United States for the current war. Another account says that it estimated Japan would need "ten years" to develop such a weapon. So it seems that the scientists viewed the project as extremely long term at best, or, as one of them would later write, "if not for this war then in time for the next one."

On the other hand, the military viewed the bomb as something to be pursued immediately, although it often did not back up this commitment with resources. The planners of Pearl Harbor, it is known, assumed that the war in the Pacific would be short, brutal, and brilliant. They believed that America, then being irrevocably drawn into hostilities in Europe, would retreat quickly from fighting on a second front in the Pacific. Did they also envision an atomic weapon that would be the climax of this war and trip the Americans into surrender?

It is well established that another faction in the Japanese government was restrained and realistic, and probably this element—much like Roosevelt and Churchill in the early phases—took a wait-and-see attitude, and relegated the problem to the scientists. But the zealots were still there. A new book, *Enola Gay*,* quotes the physicist Tsunesabo Asada's recollection that discussions of the subject right after Pearl Harbor were characterized by a "mood of blind patriotism" and "promises of generous funding."

And the scientists? Did they want Japan to become the first nuclear-armed power? Arakatsu, writing after the war, said he did atomic bomb research to prevent young scientists from being sent to fight and die. Takeuchi, in his diary, which was also compiled after Japan had surrendered, says that he did the research only when ordered, and that other Riken scientists were equally unenthusiastic.

However well these rationales suited the postwar climate of opinion, there is evidence that the actual situation was different. At several junctures when the scientists might well have closed down the work altogether—for they knew better than anyone how great were the odds against success—they kept the work going. Was it from "blind patriotism"? Or were they, to borrow a phrase later used by J. Robert Oppenheimer, fascinated by the "sweet problem" of the explosive potential of the atom?

September 1940 had been one such juncture: March 1943 was another. Following the physics colloquium's negative report, the Navy branch that had sponsored it lost interest in the atomic bomb, partly, says one account, because it was deeply concerned with the "radiowave detector" or radar, as a defense in the increasingly protracted and difficult war in the Pacific. But Nishina managed to keep the Riken atomic research going by suggesting that the research sponsorship be unified. Hence the Army, which had been funding the work since December 1940, became the sole sponsor of Riken atomic research.

But this was by no means the beginning of coordination among the military. Just as the Naval Institute of Technology bowed out of support of atomic research in March of 1943, another Navy branch, the Fleet Administration Center, was sponsoring another group of researchers at Kyoto University, under Arakatsu, to work toward an atomic bomb.

But the deal Arakatsu struck with the Navy was vague. Arakatsu writes he told his Navy sponsor, "We think a bomb can be made on a theoretical basis, but aren't sure of the practical side. It will be good if we get a lot of uranium, but anyway we'll try it. Good enough?"

"Good enough," said the Naval interviewer.

The Kyoto project, also known as project "F-Go" or "Number F" (in which the F stood for "fission") began in 1942 and was enlarged with a grant of 600,000 yen in 1943, according to social historian Hirosige. Among other things, the money went to construct a cyclotron at Kyoto University. But the military's commitment to the work—however strong in spirit—was not backed up with material aid. Arakatsu recalled, "We had to make a part by part list for cyclotron construction, and after great difficulty got them on ration. . . . The students worked hard, despite the continual need to go out and scrounge for materials." Besides the cyclotron, the Kyoto group wanted to build an ultracentrifuge to separate uranium, but its design had only just been completed when the war ended.

Meanwhile, back at the Riken in Tokyo, Nishina had been seeking to make the atomic research project more systematic. Takeuchi's diary says that in March 1943, Nishina ("The Professor") instructed his staff to work on the following guidelines:

> 1. Treatment of several hundred tons [of uranium] should be carried out after completing preliminary tests.
> 2. For the time being it will be for about four 5-meter tubes (300 mg/day).

"The Professor" also recommended that the determination of "whether the explosion is successful or not" be made "on the basis of tests carried out in parallel to thermal diffusion." This instruction is important, for it is among the few shreds of evidence that Nishina, at least, wanted to organize the project on a large scale and along the systematic lines

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Edwin O. Reischauer, University Professor at Harvard and a well-known Japan scholar, told Science *he had not previously heard of Japan's atomic bomb research during World War II. But he added that it did not surprise him.*

> I have always assumed that the Japanese would have done whatever they could to develop the atomic bomb during the war, and if they had had it, would have used it. I have always assumed that any country that could have had the bomb during the war would have used it, the Nazis, the Soviets, and the Japanese. So we were not unique.
>
> The Japanese public reacted very strongly after Hiroshima and Nagasaki and insisted upon the government's postwar policy that Japan does not and never will seek to acquire atomic weapons.
>
> But the government has not said, to my knowledge, that before and during the war it didn't try to develop the atomic bomb. Probably what happened is that few Japanese knew it had done so, and, after the war, those who knew found it too embarrassing to speak about.

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*G. Thomas and M. M. Witts, *Enola Gay* (Stein & Day, Briarcliff Manor, N.Y., 1977), $11.95.

which, unknown to him, were proving crucial to the success of the Manhattan Project in the United States: namely the conduct of several parallel experiments whose results could be fed into a single chain of technical decisions.

But Takeuchi's diary also indicates that atomic research at the Riken was anything but coordinated. Takeuchi complains that although he was told to consider the possibility of separating uranium by electromagnetic means, Miyamoto, who had developed such a method, had gone to another university. So, Takeuchi explains, he gave up on electromagnetic separation because he couldn't have Miyamoto around to help. Similarly, although Takeuchi found gaseous thermal diffusion "the most promising" method, another scientist, Eiichi Takeda, who had done small-scale thermal diffusion work using a glass column, was not assigned to the project. So, Takeuchi had to start from scratch.

After much delay and red tape of the sort that Arakatsu had complained, the apparatus was ready in a separate building in early 1945. It is noteworthy that Takeuchi seemed to have more of a theoretical than a practical orientation. It took him 18 months to do this work, whereas physicists in the United States were able to set up comparable or larger experiments in a matter of weeks.

In the course of the work Takeuchi made an interesting, roughly correct, calculation. Since no heavy water was available to use as a moderator for the chain reaction, light water would have to do; he calculated he could scale down the size of the reactor if the uranium were enriched to 5 to 10 percent.

It is not clear whether Takeuchi's apparatus consisted of one or more separate columns but a single column was 5 meters long and the thermal gap between the concentric tubes inside was 2 millimeters wide. Ten military officers were assigned to the laboratory in 1944 to help, and the tubes were first run with argon gas with no result.

The scientists wanted to test it more but the military insisted on a "one shot gamble" so the precious stocks of uranium hexafluoride that had been produced in the laboratory began being stoked in the column and the results examined on the big cyclotron.

But at this very moment, in April 1945, as the gaseous thermal diffusion apparatus and the cyclotron were finally working together in an experimental mode, the building housing the apparatus—but not the cyclotron—was ruined in the American bomber raids over Tokyo. The wrecking of their experiment caused the scientists to give up on their atomic research—that is, until after Hiroshima.

(It should be noted that another, less reliable account of Japan's atomic bomb activities during the war, by one Yoichi Yamamoto, who claimed to have been involved in the geological aspect was published in *Dai-horin* magazine in 1953. Yamamoto claims that the impetus behind the Japanese effort went well beyond research in the physics laboratories. Yamamoto claims that the impetus behind the Army's and Navy's interest were two sons of the emperor, Prince Mikasa and Prince Takamatsu. The two princes, besides urging on the scientists, also sponsored extensive geological surveying and prospecting for uranium in Manchuria, Korea, and in Japan itself. Yamamoto even wrote that in 1944 Japan received a shipment of 500 kilograms of uranium oxide from the Germans by submarine!

(The article scores Nishina for hogging all the bomb project money for his theoretical physics work, and failing to see that the job was really a technical and engineering one. But it confirms other accounts of the pathetic persistence of the Japanese to achieve such a weapon, in the later, desparate phases of the war. For instance, it claims that late in the war schoolchildren in Japan were sent into the mines to help dig for uranium!

(The Yamamoto account is not confirmed by other, first-hand source material in the possession of American scholars, and so has not been given much weight by them. On the other hand, it highlights the fact that the reliable documents so far unearthed deal only with the work of the scientists, and not with other crucial questions, such as whether the government did prospect for uranium, or any communication Japan had on the subject with Germany.)

The story of Japan's atom bomb research could have ended here, with the accidental destruction of the chief activity the scientists had undertaken. Instead history was to visit on them more terrible retribution.

For one thing, after Hiroshima, the government seems to have become interested yet again in having an atomic bomb. According to one account, the morning after the bomb was dropped, when terrible rumors had reached the government in Tokyo, Nishina was summoned and asked first whether the bomb could have been atomic and "whether Japan could have one in six months."

The account does not chronicle Nishina's reply to this last question but he was flown over Hiroshima on 8 August. The pattern of destruction and the presence of radiation convinced him the bomb had been an atomic one. Arakatsu reached a similar conclusion when he was flown over the city on 10 August.

One can only speculate what were Nishina's emotions when he looked down at the ruined city, and realized that his committee's calculations, that "even the United States" would not be able to build an atomic weapon for the current war, had been wrong. Did he feel professionally piqued that America had succeeded where Japan had failed? Or was he, like some other physicists in other countries, horrified by the consequences of "the sweet problem"? Was that aerial survey—the first by a high ranking Japanese in a position to know what had happened—the moment when the curtain of silence began to fall?

After Hiroshima, the scientists at the Riken resumed their atomic studies, but with a different goal, namely to learn about the effects of the weapons at Hiroshima and Nagasaki. Philip Morrison, now of M.I.T., who served on the Manhattan Project and arrived in Japan on the first day of the American occupation, recalled what he found when he visited the Japanese scientists.

Nishina was "guarded and self con-

Herbert F. York, director of the Program on Science, Technology, and Public Affairs at the University of California at San Diego, has written extensively on the history of atomic weapons and arms control. York believes the Japan atomic bomb story has a lesson for current concerns about nuclear proliferation.

Two points. First, the Japanese story completes the set, that every nation that might plausibly have started a nuclear weapons program did so: Germany, Great Britain, the United States, the Soviet Union, France, and, we now know, Japan. So the case has been weakened of those who have argued that governments, or more precisely, the generals, emperors, and presidents, can hold back from this decision and say "No." The decision to develop nuclear weapons is not a fluke of certain governments, but a general, technological imperative.

A second point I would make—and this cannot be proven on the basis of the Japan story alone—is that it is not the generals, emperors, or presidents who are the driving force behind a country's development of nuclear weapons. It is the cadre of scientists and engineers, who go to their governments and say "Look what we can do. If you give us this and this, you will be that much closer to having a nuclear bomb if you should ever want one." I believe that this is happening in other nations of the world today.

Nonfuel Minerals Study

A Nonfuel Minerals Policy Coordinating Committee has just been established by President Carter with instructions to submit its policy recommendations and options to the White House within 15 months. Secretary of the Interior Cecil D. Andrus, who will head this major interagency policy review, says that "rapid changes in the availability and use of critical nonfuel minerals make it imperative that we analyze current policies bearing on the supply and demand picture, as well as the domestic and international implications of changing those policies."

The major focus of the study will be on those minerals regarded as most critical to the U.S. economy, such as copper, aluminum, iron, zinc, manganese, chromium, lead, nickel, and tungsten. The undertaking of such a nonfuel minerals policy review was first proposed (*Science*, 25 November) by a group of congressmen led by Representative Jim Santini, a Democrat from the big mining state of Nevada and a prominent member of the House Interior Subcommittee on Mines and Mining.—L.J.C.

tained . . . impassive and almost antagonistic," toward the arriving Americans. "He seemed to wear a heavy administrative burden." On the other hand, many other Japanese physicists seemed to welcome the Americans with "rueful pleasure," Morrison told *Science*. Morrison recalls that the feelings of internationalism, of a bond among physicists, seemed to reestablish itself between the Americans and the Japanese—with the exception of Nishina. And as for whether Japan had been developing an atomic weapon, he recalls, "they didn't talk about it and we didn't ask about it much."

The Riken buildings and laboratories "looked frayed, unrenovated, starved of attention." In places, work had just stopped and people had gone away. Morrison recalls a single scientist at the Riken named Kimura, who was measuring radiation with two small electroscopes and some chemical equipment. "He cooked and ate and worked in the same room in the laboratory, and was growing some potatoes in the yard. . . . He was doing work that we had done in America with a whole panoply of people. So, as we looked around we concluded this could not have been the site of a Japanese Manhattan Project."

It is not surprising that U.S. scientists visiting Japan, who knew firsthand the "panoply" of installations and people that was the American Manhattan Project, concluded that the Japanese could not have had a comparable project. Arthur H. Compton and E. L. Moreland, who visited the Japanese scientists later in 1945, likewise recommended that the occupation forces "treat them gently," according to a later letter by Vannevar Bush.

So it went in the fall of 1945. Visiting American scientists were sympathetic to Japanese "colleagues" and tended to find no evidence of a bomb project. The Japanese were silent to their American military interrogators; thus the military, by and large, also found no evidence of such a project.

Officially, therefore, the scientists were indeed to be treated gently. The Joint Chiefs of Staff ordered on 30 October that all research facilities and equipment "on atomic energy and related subjects be seized." "No research . . . on atomic energy shall be permitted in Japan."

But a second order authorized on 7 November 1945 by someone in General Groves' office ordered that the two cyclotrons at the Riken, the two at Osaka Imperial University, and the one at Kyoto be destroyed. The order went through channels to MacArthur's headquarters in Tokyo, and was duly executed on 24 to 26 November 1945. American military teams visited each location and proceeded to hack the cyclotrons to pieces. They took the remains, and dumped them into the sea.

The brutality of the act can be seen in the cold words of the American press in Japan which was accustomed to chronicling American victories against the crafty Japanese foe. Wrote the *Nippon Times*:

> Nishina was heartbroken when American officers told him today at 8:30 a.m. that his huge cyclotron was going to be demolished. His secretary broke down and cried.
>
> But secretary Sumiko Yokoyama, composed, was brought in to talk to correspondents before the potential atom smasher. . . .
>
> American officers and scientists talked to her for two days through an interpreter and then found her reading an English book "The Citadel."

The paper added that the "smashed" instruments would be taken "well beyond the 100 fathom mark" in Tokyo Bay "to be sure they are lost in the sea." As though the Americans feared that the Japanese might collect up the broken instruments and glue them back together, *Stars and Stripes* reported, "When the job is finished five cyclotrons and related equipment will have been blown to bits or sunk in the ocean."

The significance of the incident is hard to underestimate. In the furor which arose in the United States, scientists' and citizens' groups, from Oak Ridge to the University of Michigan Medical School, protested to the Secretary of War. For the most part they were told that the destruction order had been a mistake. But this confession of error only whetted the appetites of many of the scientists, who had become embroiled in the weeks since Hiroshima in a fight for future civilian control of atomic energy. The destruction of the cyclotrons was used, in congressional testimony and elsewhere, to show how insensitive the military would be to the special needs of science and scientists.

Admiral Nakamura "Talks"

But was the destruction completely mindless? Did Groves' office—to which flowed all Allied intelligence on atomic energy matters—know of the wartime use to which the cyclotrons had been put? The curtain of silence may have at one point lifted.

A document in the collection of M.I.T.'s Weiner is by Colonel Manson of General Headquarters in Tokyo and dated 10 October 1945—that is, after Hiroshima but before the Groves order to destroy the cyclotrons. In it a certain Rear Admiral Nakamura reports in detail on atomic bomb research conducted during the war at Kyoto University. Among other things, it says that the project included the construction of a cyclotron.

Weiner notes that so far there is no evidence that the report was forwarded to Washington and reached Groves' office. But its existence suggests that some Americans learned of the wartime atomic research and concluded that the cyclotrons should be destroyed.

Moreover, documents in the U.S. National Archives show that the military repeatedly hinted that the fate of the Japanese cyclotrons might have been justified. In separate questions from two reporters, for instance, both the Secretary of War and Groves were asked what they would have done if they had had a chance to review the order before it was sent. They both replied in identical lan-

guage, that they didn't know what they would have done.

And on 31 December when Lee DuBridge, director of the M.I.T. Radiation Laboratory, wrote to the acting secretary of war on behalf of the scientific community, suggesting that U.S. scientists restore "at least Dr. Nishina's 60-inch instrument" in view of the great loss to physics and the world, Acting Secretary of War Kenneth C. Royall replied:

> It is unsound to intimate that scientists are citizens of the world alone, are internationalist and not loyal to their native lands and are never willing participants in the ambitions of dictators or tyrants. The evidence to the contrary is too overwhelming for the American public to accept this thesis, for modern war is scientific and total war in toto. Without the scientist or the technical worker the terrible instruments of destruction of the present day would not have been possible.
>
> In the interests of the country and of the American scientists themselves, I believe you should exert your influence to prevent any campaign for the restoration of a cyclotron to the Japs at this time. . . .

The end of the story concerns the fate of the Riken and Japanese physics after the war. Both the Japanese historians, Hirosige, and the anonymous narrator of the science and technology history, note that in America, "the bomb project was opportunity and gathering of scientists, and marriage of science to large scale technology and engineering and production," and that other nations, particularly America, "positioned themselves and physics" for the postwar period.

But in Japan the result was the opposite. The Riken was dissolved "as a result of the defeat," although Nishina later raised money to reestablish it on a different footing. Elsewhere in Japan, physicists were restrained from atomic research, and allowed only to work on applications to biology and medicine. But without the big equipment to support pioneering work, Japanese physics did not reattain the prominence it had had in the 1930's. As the historians conclude, the physicists and their laboratories were "victims" of the war.

Could the Japanese have had an atomic bomb in World War II? All the historians, Japanese and American, echo the conclusion of the Physics Colloquium, that Japan did not have the uranium, resources, or organization for a full-scale Manhattan-style project. So the danger—as turned out to be the case with the Germans—was not a real one.

But the historical importance of the project lies not in the fact that Japan failed but that she tried, and that Japan's postwar attitude, that she, as the one nation victimized by atomic weapons, is above seeking to acquire them for herself, is not historically accurate. The historical record shows—on the basis of the eagerness of her military and the willing cooperation of her scientists—that if other factors had made a bomb possible, the leadership—which by the end of the war were placing their own youth in torpedoes to home them on the advancing U.S. fleet—would not have hesitated to use the bomb against the United States.—DEBORAH SHAPLEY

Pollution: Chemical Company's Effort to Sue Its Accuser Fails

In a quiet country courtroom in the small Eastern Shore town of Denton, Maryland, a conclusion that is sure to please environmentalists was reached last month in an obscure court case with potentially far-reaching implications. For what appears to be the first time in this country, a firm accused of pollution had sued its principal accuser for defamation after the firm had been forced to close as a result of massive adverse publicity. A jury, however, dismissed the suit, concluding in effect that the physician who had publicized the firm's pollution problems had merely fulfilled his responsibilities as a scientist by making his discoveries known. The story of the battle between company and physician contains no small touch of irony, moreover, because the company itself was originally founded to alleviate another pollution problem.

Paul J. Mraz was a chemical engineer with the Dupont Company when he observed that Dupont and other chemical companies in the Northeast corridor were forced to dump spent solvents because it was not economical for each of them to recycle the relatively small amounts each produced. He reasoned, probably accurately, that a tidy profit could be turned and an environmental problem eliminated if solvents from each of the companies were collected and distilled together, and then the purified solvents were sold back to the companies. His big mistake seems to have been in choosing a Maryland valley as the place for his plant.

Solvent recycling was never destined to be an immensely profitable business, so Mraz chose an inexpensive location, a burned-out paper mill in the bucolic Little Elk Valley near Elkton, Maryland. He installed distilling equipment, christened the firm Galaxy Chemical Company, and began operating on weekends in 1961. By 1965, Mraz was able to quit his job at Dupont and devote all his time to the fledgling company. Between 1965 and 1977, the company processed more than 8 million gallons of solvents; its income peaked at $438,000 in 1974.

Mraz traces the beginning of his problems to 1967, when pathologist Pietro U. Capurro took a position at the Union Hospital of Cecil County in Elkton and purchased a home in the valley. Shortly thereafter, Capurro noticed in the valley a frequent odor that has been described at different times as "gluelike," "disagreeable," "pungent," "vomitlike," "skunklike," and "peppermintlike." The chemicals responsible for the odors collected in pockets in the valley and lingered there much longer than they might have in the open. He soon found, moreover, that members of his own family and more than a quarter of the 200 or so residents of the valley had become mysteriously ill, complaining of eye and nose problems, headaches, indigestion, abdominal pain, weight loss, nausea, fatigue, and other ailments.

Physicians visited individually by citizens of the valley were at a loss to explain the ailments, presumably because they saw only one or two of the residents of the valley and were not familiar with the conditions there. Ultimately, a number of residents were examined by Capurro or by Eloise W. Kailin, then an allergist in Silver Spring, Maryland. Each recognized the classic symptoms of poisoning by chemical fumes.

Both physicians alerted the Maryland State Health Department to the problem, but that department was slow to act. Capurro and other residents began a letter-writing campaign to local and state offi-

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