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Meet Our Museum Podcast: Fifty Years of Lasers

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Audio-only Podcast online at: http://americanhistory.si.edu/thinkfinity/podcast/laser.mp3

Enhanced Podcast online at: http://americanhistory.si.edu/thinkfinity/podcast/laser.m4a

Codes:

MR = Matt Ringelstetter

HW = Hal Wallace

" " =interrupting, pause

[ ] = not speaker's words

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MR = This year marks the 50th anniversary of the laser; an object of science that has long captivated the minds of science fiction writers, military strategists, and the public alike. Did you know that Albert Einstein was one of the scientists who worked on the more theoretical side of the laser or that the word laser, itself, is an acronym short for light amplification by stimulated emission of radiation? In 50 years, lasers have come a long way. From the first *masers*, the original pre-cursor to light-amplified radiation to the eventual practical use of lasers in supermarket checkout counters, home entertainment systems, and surveyors' tools. This the History Explorer Meet Our Museum Podcast and in this month's episode we speak with Hal Wallace, curator of the Electricity Collections, here at the Museum of American History to discuss the development of the laser and what it's meant to American culture and history.

HW = I'm Hal Wallace. I'm the curator of the Electricity Collections, here at the National Museum of American History and I am the curator of the exhibition Fifty Years of Lasers and we're currently in the anniversary year of not one but three different kinds of lasers.

MR = So, Hal, can you talk about the development of the laser and perhaps when was the first laser developed and what was it used for.

HW = Okay. The laser experiments come out of World War II and materials research set up during the war. The ground work was laid beginning early in the twentieth

century by Albert Einstein thinking about stimulated emission and scientific properties by which atoms and molecules can emit radiation. This stayed in a highly refined scientific sense for many decades. Coming out of the war a physicist of Columbia University, Charles Townes, had been looking at microwaves and specifically microwave spectroscopy and microwave communications during the war; radar systems which work on microwaves, and after the war began thinking about other ways you might use microwaves supported by funding from the U.S. Navy primarily and other sources as well developed an amplifier based on Einstein's theories and prior experiments done by Nicholas Blaumberg and others. Townes developed this amplifier for microwaves using stimulated emission of radiation; microwave amplification by stimulated emission of radiation or maser.

MR = Okay.

HW = This was in 1954. Masers were reasonably easy to do compared to later lasers because the energy level for microwaves is lower. Lower energy level microwaves which got people interested in the physics and showed that stimulated emission could be done. The maser ultimately didn't find much application however everyone began to realize that if you could bump the energy levels up, get shorter wavelengths of radiation, you could begin to get into light. And once you could get into light a lot of other applications could come forth.

MR = So the maser didn't emit any light?

HW = No. It emitted microwaves. Now the microwaves acted in the same manner that light acts in a laser. The beam is highly focused, doesn't spread out but it is microwave wavelengths so the wavelengths are a bit longer than they are with light.

MR = Okay.

HW = Townes and his brother-in-law, Art Shawlow, at Bell Labs began experimenting with shorter wavelengths and in 1959 hosted a conference called Quantum Electronics and they brought in scientists from all over the country who were working in this area. By this time people were beginning to work on what they called an optical maser; a maser that would work at optical wavelengths. Now some people wanted to use ruby crystals for masers and had done so and there were several papers presented why a ruby crystal really wouldn't work well in generating the light. Now one of the attendees at the conference was Theodore Maiman of Hughes Aircraft, and he had done some work with ruby maser crystals and he just didn't quite get what he was hearing; something didn't sound right. So he went back to his lab at Hughes after the conference and began experimenting with rubies in different ways. And in May of 1960, he and Ernie DeHaynes, his assistant, demonstrated the first working laser. A small crystal of ruby, a small cylindrical crystal of ruby, set inside a spiral photographer's flash lamp and all mounted in a little metal housing. We may have the first crystal and the first housing on display here in the showcase. There's some question about, you know, do we actually have the first.

MR = I'm sure there's always that question whenever an exhibit is being put together.

HW = Exactly. But, this *may be* the first laser and the first laser crystal. Maiman published his experiments, published the results of his work and others began replicating his work. You'll see on display from 1963 a ruby laser from Ohio State University where the researchers there were building on what Maiman had done just to see [if they could] you know replicate the experiment which is one of the ways science works and to play with the parameters a little bit and see what effects they could get. At Bell Labs the Iranian immigrant Ali Javan who had studied with Townes at Columbia and taken his PhD under Townes started thinking about gas lasers and he came up with a helium-neon laser that produced a continuous beam of light. This is quite important and just a few feet away from Ali Javan's laser you'll see one of the first supermarket scanners that actually use a helium-neon laser. So, 14 years after Ali Javan demonstrates the helium-neon laser you have the introduction of supermarket scanners that utilize this technology.

MR = So the process is, so far, has been this theoretical idea of amplified emissions and then the maser and then soon after that was the laser which is the optical version or somewhat of the maser, if I can summarize a little bit, and then you've got a few years later a continuous light and then we're already in a practical use of it in the grocery store.

HW = Right, where in this case, a few months later you go from a pulsed laser of Maiman's and Sorokin's and December of 1960 Javan demonstrated his continuous beam of light. There's some question. Scientifically there's not a whole lot of difference between a maser and a laser. They just work at different wavelengths. There are technical differences and it was more difficult to produce a laser because it operates at a higher energy level but the big difference are the applications, so many different applications, so many different things you can do with that higher energy level of light that you couldn't do with microwaves. One of the immediate thoughts on everyone's mind and attracted the military's interest especially was the idea of laser weapons.

MR = Oh yeah.

HW = This idea of death rays or ray guns that gets picked up in science fiction beforehand in the works of H. G. Wells and others and appears very soon on TV in Star Trek, for example, with the phaser. So you even had the name being worked into the science fiction. This idea, everyone could grasp this idea of a directed energy weapon, which is what we call it today and it's a fine idea if that's what you're after and you can do it in the lab and we have a 1985 target on display of six steel plates with a hole burned right through 'em front to back by a chemical laser of the U.S. Army's Red Stone Arsenal but it's difficult to do under battlefield conditions. It's difficult to do in the real world. Actual way that laser weaponry developed was not like the fantasy. It's a fantasy reality situation. The fantasy is this ray gun that just blows up or disintegrates the target. The reality is soldiers today, marines, will use a laser target designator to put a laser beam spot on a target and a sensor on a shell or a bomb, missile will home in on that spot and destroy the target. So the laser is an indirect weapon not a direct weapon. The other

major military use for lasers right now is range finders. Laser range finders in American tanks make them exceptionally accurate on the battlefield and [are] one of the reasons in the 1990 Gulf War why our military just tore through the numerically very powerful Iraqi military.

MR = Hm. So aside from the military and you said that one of the first practical uses was in the grocery store something that everyone has an experience with, what were some of the other first practical uses for lasers?

HW = Lasers very quickly became used for leveling and surveying applications. This idea of accurately measuring distances with a laser beam took hold very quickly. We do have a laser level and laser light detector on display in the exhibition. That becomes one very early application. The laser scanner for the supermarket scanner required more than just a laser. The laser had been developed but you also needed something for the laser to scan so the development of bar coding, which was a history all of its own, [which] required buy in from many different manufacturers and organizations and companies technical companies or organizations as well as companies like IBM, for example, and National Cash Register and others had to agree on the format of the bar coding, where it might be placed, how it would be read. Once all these generally policy decisions were made then that technology coupled with the laser and emerging computer technology to process the information could all be combined in an automated cash register system so you have Spector Physics developing the scanner that you see on display and National Cash Register developing the computerized cash register that coupled to it to make the complete system.

MR = It's interesting to see how, you know, how the history science and something so technical can start to lead into really just the history of consumerism in this country and the way that people buy things and interact with stores and things like that.

HW = Indeed. We tend to make a differentiation between basic science and applied science. Basic science we tend to think of as knowledge for knowledge's sake and applied science being something specifically designed for a particular project. In a sense, the differentiation though is arbitrary. Where does basic science stop and applied science begin? Many people argue that there really is no difference. Science is science. As one Army person said, "It's all in the eye of the beholder as to what basic science is and what applied science is."

MR = Interesting. What do you think that lasers and the history of the development of lasers can teach students that they might not be learning about by reading a textbook?

HW = First, there's more than one way to invent something. History is not pre-determined. There are many paths that can happen. History happens in one particular fashion for a variety of reasons, but there are many potential paths. That's why you see in 1960 not one but three different lasers being invented within the span of six months. These were all the culmination of different research programs at different companies and universities all paying off at about the same time. This idea of multiple developments, of multiple paths to history is definitely something to bear in mind and

for high school students, as well, to question the source. Don't get locked up in this idea of the first. Because just looking at this showcase for example. When it comes to an object, do we have the first laser? We believe so, that's what Hughes Aircraft, the donor of the material, told us in 1970 when they donated the material, but the inventor Theodore Maiman, said that he had the first laser and kept it when he left Hughes Aircraft not long after the invention. There were several of these things in the lab about the right time. We'll never really know which is the first laser. In a sense, does it really matter?

MR = Exactly.

HW = We know the invention took place in that place at that time and it's the results and the effects that really count. Also, that invention can come out of usual places. No one expected Maiman to develop the first laser. No one expected Hughes Aircraft out on the West Coast away from the East Coast Ivy League research area to actually succeed and that took everyone by surprise to the point where Maiman's paper was initially rejected for publication because the editor of the journal thought that it was just another maser paper. It turned out that it wasn't.

MR = That's interesting. Hal I've got to thank you for joining us today. I'm sure all of our listeners will find this really interesting and informative as well.

HW = My pleasure.

MR = That was Hal Wallace tracing the development of the laser. To learn more about lasers and see some cool photos visit the American Institute of Physics page on the subject found at www. aip.org/history/exhibits/laser. For the History Explorer Meet Our Museum Podcast, this is Matt Ringelstetter. Tune in again next month to learn more about what goes on here at the Smithsonian's National Museum of American History. Funding provided by the Verizon Thinkfinity Foundation. Music by *kindswider*. To hear more, go to freemusicarchive.org.