



News from the Lemelson Center for
the Study of Invention and Innovation **Behind every invention there's a story**



Smithsonian
National Museum of American History
Lemelson Center for the Study of Invention and Innovation

from the Director

Cultures of Innovation

Three years ago, The Lemelson Foundation, which funds eight U.S. programs including the Lemelson Center, launched an ambitious new international initiative. Its Invention for Sustainable Development Program is designed to promote invention “to meet basic human needs and build sustainable livelihoods for the world’s poor,” as described on the foundation’s website at *lemelson.org*. I was invited to participate in several planning sessions, including one at Costa Rica’s EARTH University, a private international university devoted to sustainable agriculture, and another involving a consortium of institutions, in Yogyakarta, Indonesia (the latter ending just before the tsunami ravaged the neighboring island of Sumatra). These gatherings provided a rare opportunity to meet



Photo by Arthur Molella

inventors from around the developing world, operating under widely diverse circumstances but facing similar economic, social, and political challenges. All of these inventors shared their essential motivations: a desire to improve the quality of life for themselves, their families, and societies, but most basically, an unquenchable

Banana sorting at EARTH University. Modified organic techniques are used to grow the fruit and waste products are used to make banana paper.

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enthusiasm for the act of inventing itself.

Beyond this shared impulse, however, were some surprising differences in circumstance. Even within the narrow geographic compass of the Central American isthmus, wide variations in social, cultural, and political climates for invention were displayed, or at least perceptions thereof. Honduran participants at the EARTH University workshop, for instance, identified an ingrained general resistance

was also proudly noted.

A recurring theme of the Lemelson Center revolves around the basic question of how myriad societies, past and present, can nurture or, in some cases, can hinder innovation and inventors. Our first symposium, *The Inventor and the Innovative Society* (1995), ranged in time and place from Leonardo's Renaissance Italy to Edison's metropolitan New York and Frederick Terman's Silicon Valley. One key finding was that societies strong on innovation also tend to generate vibrant arts communities. Now, ten years later, we will widen our lens to include the experiences of developing countries. Our international workshop on *Cultures of Innovation*, to be held in Washington, D.C., in May, will look across nations and cultures and encompass both factors encouraging positive technical change and factors leading to resistance to innovation. Although it is difficult to predict results from this workshop, one can surely say that invention is an international theme with almost limitless possibilities. At the Lemelson Center, we look forward eagerly to encounters with invention's infinite variety.

Arthur Molella
Jerome and Dorothy
Lemelson Director



Photo by Arthur Molella

Working with
banana paper at
EARTH University

to change in Honduran society as a limiting factor on invention. Neighboring El Salvador, on the other hand, was held up as a model entrepreneurial culture, despite its poverty and recent history of violence. Cited examples of inventions and innovations from the latter nation included a low-temperature wood-burning stove and a robotic cart for detecting and collecting dangerous materials such as chemicals and land mines, technologies reflective of the particular needs of the region. That El Salvador bestows an annual award for innovation



The Birth of *Electronic* Dance Music

By Will Eastman, Project Historian

The Russian Revolution of 1917 conjures images of sweeping changes for a nation, a people, and world history. As in Nobel literature prizewinner Boris Pasternak's *Doctor Zhivago*, the backdrop of the revolution plays host to countless smaller stories of individuals living their lives against its monumental geopolitical effects. One real-life story from this age unites invention, cold war politics, and, surprisingly, electronic dance music. It's a story that offers a prime example of the Lemelson Center's efforts to examine the history of invention and offer it a modern context.

The National Museum of American History maintains a world-class collection of musical instruments, including the Herbert R. Axelrod Quartet of decorated instruments by Antonio Stradivari, a portable upright piano made by John Isaac Hawkins of Philadelphia in 1801, and a five-string fretless banjo made by William Boucher Jr. in 1846. The Museum's holdings also document a rich electronic musical heritage dating back to the early 20th century. These roots do not come from America nor any European country often associated with the cre-

ation of new and innovative music and style. Rather, the birth of electronic music—in particular electronic dance music—can be traced to a lone inventor in the Soviet Union: Lev Termin (1896–1993). As he worked to fashion a simple security alarm, he instead gave birth to electronic music.

Termin (later, Leon Theremin), drawing on early-20th-century radio and electrical technologies, radically expanded the range of sounds available to musicians and composers. He invented the first synthesizer, a device that electronically produces sound from a network of one or more circuits, creating an audio signal. Using two antennas to control the pitch and volume, Theremin gave the world the gift of electronically synthesized music. Patented in 1924, this synthesizer, or “Aethero-*phone*,” which was later dubbed, simply, “Theremin,” set off a chain of inventions that would in turn create new ways to make and perform music. In the 1960s, the principles of the Theremin would be further developed in the production of the first keyboard synthesizers. The Theremin's otherworldly sound became familiar in science fiction films



Leon Theremin,
about 1924

Photo courtesy of Lydia Kovina



and achieved pop culture status after being prominently featured in the Beach Boys' October 1966 number 1 hit, "Good Vibrations."

But Theremin didn't stop there. Lesser known than his synthesizer, the Rhythmicon of 1931 is the earliest electronic rhythm machine and the forefather of the "beat box," or drum

National Museum of American History.

Throughout the 20th century, many inventors built on Theremin's legacy, helping to bring sounds of electronic music from rarified laboratories to neighborhood musical instrument shops. In 1968, Wendy (once Walter) Carlos released *Switched-on Bach*, a recording of Bach's music using only a Moog synthesizer. It went down in history as the first platinum-selling classical music album. The first commercial synthesizer, Robert Moog's Minimoog (1970), became the first purchased in significant numbers by rock musicians. By the 1970s, synthesizers went from analog to digital and were pushed to their limits by musicians like Keith Emerson of Emerson, Lake and Palmer.

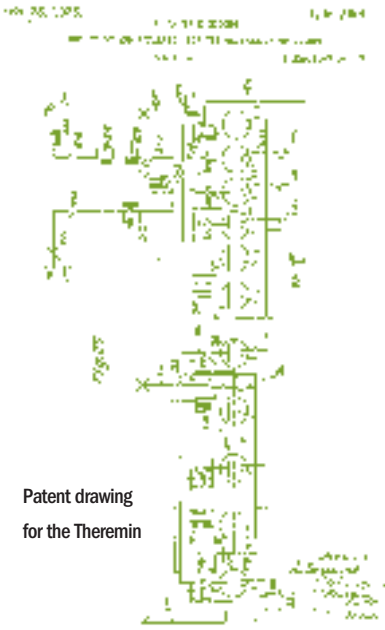
From 1996 to 1998, the Lemelson Center funded a series of oral-history interviews documenting the pioneering engineers and musicians of the electronic music synthesizer. Concentrating on important figures of the 1960s and 1970s, the collection contains approximately thirty hours of master tapes and transcripts. Trevor Pinch, professor of sociology and chairman of Science & Technology Studies at Cornell University, conducted the interviews and also produced a detailed collecting plan for objects documenting the invention and development of the analog music synthesizer. With support from the Lemelson Center, Pinch published *Analog Days: The Invention and Impact of the Moog Synthesizer* (with Frank Trocco; Cambridge, Mass.: Harvard University Press, 2002).



National Museum of American History Archives Center, George H. Clark Radioana Collection

Alexandra Stepanoff, a former concert singer who was Theremin's first student in the United States, playing the Theremin on a syndicated NBC radio broadcast, 1930

machine. Theremin's model, constructed for experimental music composer Henry Cowell, exceeded human capabilities—it could play sixteen different rhythms in three parts simultaneously. The instrument produces various drumbeats or rhythms using a unique mechanism of light sources and rotating, holed wheels. Of only three known Rhythmicons built, one resides in the collections of the



Patent drawing
for the Theremin

Among musical genres, the foundation laid by Leon Theremin for electronic music is unique—he can rightly be called its father. He demonstrated his Aetherophone to Lenin, worked in the United States in the late 1920s and the 1930s to promote the new instrument, and became the toast of New York society. Yet his story takes an unexpected turn. Theremin disappeared suddenly from New York in 1938. Sent to a labor camp, then to work on top-secret Soviet intelligence projects, including a device used to bug U.S. diplomatic offices, Theremin was presumed dead for nearly thirty years.

In 1967, a visiting correspondent from the *New York Times* happened on Theremin working at the Moscow Conservatory of Music. Amazed at the discovery, the reporter wrote an article about him—the first information about the inventor, once known as “the Russian

Edison,” to appear in the West since his disappearance. After the collapse of the Soviet Union, Theremin again visited a much-changed New York City. Footage of his visit appears in a 1993 documentary about his life and work, *Theremin: An Electronic Odyssey*.

With the synthesizer and drum machine, Theremin created the two main ingredients of electronic dance music, something that appeals to me outside my museum work. When I was a teenager in the 1980s, airwaves were filled with synthetic, New Wave music. European and American artists harnessed technology in the form of electronic synthesizers, prominently featured in the music videos of MTV, while drum machines and samplers helped give birth to hip-hop. Today, I work as a club DJ responsible for keeping a dance floor alive, and as I scour record store shelves for the latest import dance singles, the job continually amplifies my enthusiasm for the synthetic sounds of the 1980s and their electronic forebears.

Several evenings each month, I provide pulsing beats of electronic music to which people dance, groove, or simply tap their feet. While many of them could tell you details about the musicians and artists whose work radiates from the club speakers, I wonder how many realize the music’s connection to the birth and death of the Soviet Union, the enigmatic life of Leon Theremin, or the many inventors and innovators whose contributions have been documented by the Lemelson Center.



Time Travel

with Historian **Maggie Dennis**

It is quite fitting for the Japanese town of Suwa to be the site of watchmaking history. Suwa looks remarkably like Neuchâtel, in Switzerland's centuries-old watchmaking region. Both towns sit on the edge of a lake, surrounded by mountains. It was at Suwa that the Astron—the first quartz wristwatch sold anywhere in the world—was invented by a team of Seiko engineers in the 1960s. During my first research trip to Japan in 1999, I wondered if Seiko chose Suwa simply for its remarkable geographic similarity to Neuchâtel. I learned that the company's watch-manufacturing facilities were moved from Tokyo to this remote region in Nagano Prefecture to avoid the Allied bombing during World War II.

With my colleague Carlene

Stephens, my research took me once again to Suwa during Thanksgiving week 2004 to interview some of the Seiko engineers who had worked on the Astron. Carlene and I are writing the fascinating history of the quartz wristwatch, which was developed in pursuit of greater accuracy and invented independently by teams of engineers in Switzerland, Japan, and the United States in the 1960s. Before then, for over 500 years, watches had been mechanical. The work of these engineers set off a global revolution in the watch industry, and signaled a dramatic shift from a mechanical to an electronic world. Today's consumer electronics, from cell phones to PDAs to MP3 players, stem from technologies like quartz oscillators, low-power inte-

Suwa, home of
the Seiko Epson
Corporation



grated circuits, and small batteries that were invented for the first quartz watches.

What I personally find interesting about this project is the opportunity to study a technology that was invented simultaneously in three settings. Local differences in culture, economy, business structure, and access to technological knowledge shaped each team's approach. In Switzerland, for example, an independent lab called Centre Electronique Horloger was established and financially supported by a consortium of Swiss watchmaking firms. Electronic engineers who had never worked on watches were hired to do the job. At the Hamilton Watch Company in the United States, where the first digital watch—the Pulsar—was invented, knowledge about quartz came from the company's Military Products Division and was acquired through subcontracts with other electronics firms. In contrast, Seiko's Astron team was assembled from within the company. Many of the staff put on the team were mechanical engineers, and had to learn electronics for themselves.

The occasion for our trip was the IEEE Milestone Award ceremony in recognition of Seiko's achievement with the Astron. We were pleased to receive the invitation, hoping

that engineers who had worked on the project would be available for interviews. Seiko worked closely with us to locate the people we wished to speak to, set up interviews, and provide the services of a translator—all of which made the visit productive and enjoyable.

Doing research in Japan presents many challenges that can't be solved simply by using a translator. Because we don't read Japanese, we rely on English-language sources, have to pay to have material translated, and are not able to take advantage of Seiko's archives. We must strive to understand Japanese business practices and try to ask questions that are meaningful to those we interview. But beyond exploring the technical details of inventing the quartz watch, our research holds the potential for a greater understanding of business models that support innovation. I think it is well worth the effort.

Seiko's Astron was the first quartz wristwatch sold. This example is on display in the *On Time* exhibition at the National Museum of American History.





BITS & PIECES

Inventing Ourselves

Building Bionic Bodies, the most recent public program to support the Lemelson Center's Inventing Ourselves theme, was held at the National Museum of American History on October 22 and 23. On Friday evening, some fifty guests participated in a roundtable discussion with experts on the history, technology, and ethics of developing and using artificial internal organs, particularly hearts. Speakers included Robert Kung, lead engineer in the development of the AbioCor Total Artificial Heart, medical historian Shelley McKellar, University of Western Ontario, and bio-ethicist John Fielder, Villanova University. Program participants were able to contribute their thoughts and opinions on the topic through anonymous, handheld polling technology.

On Saturday, visitors to the Museum's first floor had many Lemelson Center activities to choose from. Nearly 100 people attended a "Portrait of Invention" with cardiac implant pioneer Dr. Robert Jarvik (*seen at top right*), who was interviewed by National Public

Artificial heart pioneer Dr. Robert Jarvik, featured in the Lemelson Center's "Portrait of Invention"



Photo by Richard Strauss

After discussing ethical issues surrounding the development of artificial hearts, participants logged their opinions through handheld polling devices.

A D.C.-area student trying her hand at facial reconstructive surgery on a plastic skull



Lemelson project historian Monica Smith helping a young visitor in the "Extrasensory You" workshop



Photos by James Di Loreto

Radio's Michele Norris. Seven teams of student inventors, mainly from Lemelson Foundation partner programs at NCIIA and MIT, showed off their wearable or implantable medical inventions for Museum visitors. Teams of high school students learned facial reconstructive surgical techniques under the guidance of experts in a "Saving Face" workshop in the Hands On Science Center. Meanwhile, young visitors designed their own artificial body parts during an art project workshop called "Extrasensory You," which repeated its success from earlier Lemelson Center programs. And artifacts from the Museum's collection of artificial body parts were brought out of storage and displayed.





Sounds about right; (l-r) Paul Reed Smith, André Millard, and David Grissom checking out the details on one of Smith's PRS guitars

Photos by Paul Rosenthal



An American Icon

Some 200 people, including Smithsonian secretary Lawrence Small (who plays classical flamenco guitar), joined the Lemelson Center for a December 3 program celebrating the history of the electric guitar. Guitar maker Paul Reed Smith and guitarist David Grissom explained how makers and players interact to create better instruments. The event was moderated by historian André Millard from the University of Alabama, Birmingham, and celebrated the launch of *The Electric Guitar: A History of an American Icon* (Baltimore: Johns Hopkins University Press), the latest book published under the auspices of the Lemelson Center. Edited by Millard, it was available for purchase and signing after the program.

The electric guitar is a subject with a long and entertaining history at the Lemelson Center. It all began in 1996 with our symposium *Electrified, Amplified, and Deified: The Electric Guitar, Its Makers, and Its Players*.



The new book, available through amazon.com, is based on research and materials from that symposium.

After the program; (l-r) Lemelson Center director Art Molella, André Millard, David Grissom, Smithsonian secretary Lawrence Small, and Paul Reed Smith

Family Science Days

For three days in February, staff of the Lemelson Center and the Hands On Science Center participated in events associated with the 2005 annual meeting of the American Association for the Advancement of Science. Hundreds of young people and many of their adult companions



Photo by Emily Guevara

Lemelson administrator Yolonda Earl-Thompson helping students make new “stuff” from objects in their paper grab bags

completed several projects designed to lead children through activities to awaken their inner inventor and to conduct experiments in chemistry and biology. Lemelson Center projects included “Grab Bag Invention” and “Extrasensory You.” Both activities are designed to help youngsters use everyday objects in inventive and creative ways.

Lemelson associate director John Fleckner trying on a young inventor’s glasses

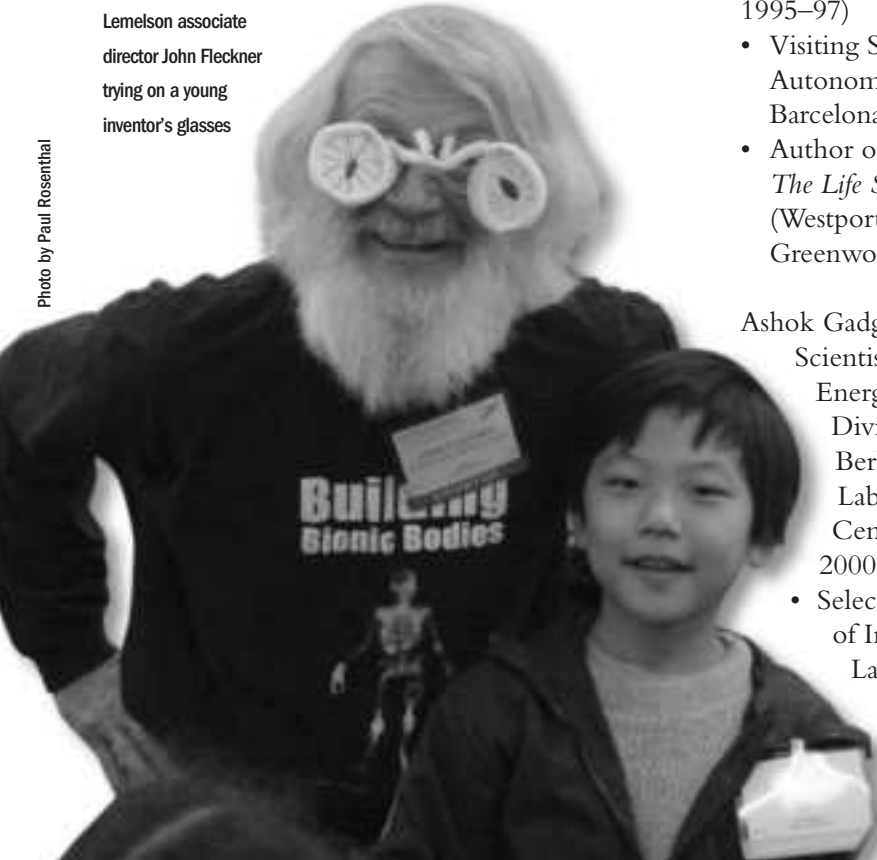


Photo by Paul Rosenthal

Invention Ambassadors Convene

On December 3, 2004, the Lemelson Center Invention Ambassadors (LCIA) held their first meeting. The LCIA is comprised of former advisors, fellows, and other associates who are no longer working directly with the Center, but still wish to assist in its promotion and success.

Chaired by former Lemelson Center Advisory Committee member Ed Pershey, participants shared ideas on what they can do in their own communities to promote the Lemelson Center and its programs and activities. Fifteen people were able to come to the meeting in Washington, but many others who were unable to attend expressed their interest in helping.

Here’s what some of our ambassadors are up to.

Rudi Volti, Professor of Sociology, Pitzer College (Lemelson Center Advisor, 1995–97)

- Visiting Scholar at the Autonomous University of Barcelona
- Author of *Cars and Culture: The Life Story of a Technology* (Westport, Conn.: Greenwood Press, 2004)

Ashok Gadgil, Senior Staff Scientist, Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory (Lemelson Center Advisor, 2000–02)

- Selected a Tech Museum of Innovation Tech Laureate for 2004, for

his UV Waterworks invention and implementation

- Featured as cartoon character in the Boston Museum of Science's most recent Engineering is Elementary book for K-4 students

Harry Allen (Lemelson Center Fellow, 2004)

- Received fellowship from the MacDowell Colony, artists' residence in Peterborough, New Hampshire

Rayvon Fouché, Assistant Professor, Science and Technology Studies, Rensselaer Polytechnic Institute (Lemelson Center Advisor, 1995)

- Author of *Black Inventors in the Age of Segregation* (Baltimore: Johns Hopkins University Press, 2003)
- Received NSF grant for "The Black Inventive Community in Washington, D.C."

Patricia Carter Sluby, Registered Patent Agent/Certified Genealogist (Lemelson Center Advisor, 1997-98)

- Author of *The Inventive Spirit of African Americans: Patented Ingenuity* (Westport, Conn.: Praeger, 2004)

Rosalind Williams, Director, Program in Science, Technology, and Society, MIT (Lemelson Center Advisor, 1998-2000)

- President (2005-07), Society for the History of Technology

Play Matters!

The Lemelson Center's traveling exhibition *Invention at Play* continues to show visitors the parallels between child's play and an inventor's creative process. Look for the exhibition at these museums and science centers.

LARGER EXHIBIT

January–May 2005
Omaha Children's Museum
Omaha, Nebraska

June–August 2005
Tech Museum of Innovation
San Jose, California

October–December 2005
Science Museum of Minnesota
Saint Paul, Minnesota

SMALLER EXHIBIT

January–May 2005
Cape Fear Museum
Wilmington, North Carolina

June–August 2005
Museum of Life and Science
Durham, North Carolina

October–December 2005
Louisville Science Center
Louisville, Kentucky

February–April 2006
Family Museum of Arts and Sciences
Bettendorf, Iowa

June–August 2006
Western Reserve Historical Society
Cleveland, Ohio



The Jerome and Dorothy Lemelson Center for the Study of Invention and Innovation

The Lemelson Center was established in 1995 with a gift from The Lemelson Foundation, a private philanthropic organization founded by inventor Jerome Lemelson.

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Alison Oswald, *Archivist*

Paul Rosenthal, *Public Affairs Specialist*

Alison Smith, *Project Manager*

Monica Smith, *Project Historian and Exhibit Specialist*

Additional support for *Prototype* from intern Emily Guevara

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