

## LEMELSON CENTER FOR THE STUDY OF INVENTION AND INNOVATION

### RESEARCH AND PROGRAM FOCUS

JANUARY 2016

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#### RATIONALE

The Lemelson Center's mission statement explains *what* we seek to accomplish as well as *why* our work matters:

The Lemelson Center engages, educates, and empowers the public to participate in technological, economic, and social change. We undertake historical research, develop educational initiatives, create exhibitions, and host public programming to advance new perspectives on invention and innovation and to foster interactions between the public and inventors.

In recent years, the Center's most successful projects have integrated historical scholarship, exhibitions, education, and public programming. Aligned to the Lemelson Center's new strategic plan, we are identifying topics of analytical focus that will: (1) provide a multi-year direction to the Center's research, programming, and fundraising; (2) demonstrate our value to the public by advancing historical insights, developing popular museum exhibitions and educational programs, and providing perspective on contemporary issues in invention and innovation; (3) strengthen our scholarly role by orienting work to questions of both theoretical and applied significance; and (4) give additional direction to cross-functional activities and programming.

In coming years, we will continue to develop two longstanding areas that consider the *role of place* in innovation and *drivers for people to become inventors and innovators*. We also will initiate research, exhibitions, educational activities, and public engagement work in the new areas of *innovation in sports* and the role of *risk and failure* in invention and innovation.

#### 1. TECHNOLOGY & INDUSTRIAL CLUSTERS

The Lemelson Center has a longstanding interest in the role of place in invention and innovation, starting with its inaugural "New Perspectives on Invention and Innovation" symposium in the mid-1990s that explored ways in which different innovative societies nurtured key inventors. Research and archival collecting since has included visits to inventors' workspaces, oral histories, and documentation of innovation sites. Additional conferences, workshops, and scholarly publications have considered technology clusters specifically and the importance of place to innovation more generally.

In 2015, the Center opened the *Places of Invention* exhibition at the National Museum of American History. The exhibit features six hot spots of American invention from the 19th century to the present and displays the historical, social, and spatial dimensions of invention, science, and engineering: precision manufacturing in Hartford in the late 1800s; technicolor

in Hollywood in the 1930s; cardiac innovations in Minnesota in the 1950s; hip-hop's birth in the Bronx in the 1970s; the rise of the personal computer in Silicon Valley in the 1970s and 1980s; and contemporary clean-energy innovations in Colorado. A digital map based on visitor input expands the concept of the role of place in invention and innovation beyond the specific case studies featured in the exhibition.

In coming years, we will continue research, archival collecting, and programmatic work to further explore innovation clusters as well as the significance of place to inventors, ranging from the national to the community to the microcosm of the laboratory or workshop. In addition, the Lemelson Center will seek ways to extend findings into the policy realm to advise on cluster policies and offer suggestions for under resourced and minority communities to revitalize themselves as places of inventive activity.

## **2. THE MAKING OF INVENTORS AND INNOVATORS**

From its inception, the Lemelson Center has carried out a combination of biographical research and work in the history of technology to evaluate and understand what inspires and motivates inventors. The Center's "Innovative Lives," "Inventive Voices," and "Portrait of Invention" programs; *Inventive Minds* exhibition; and other research and archiving activities have drawn attention to the inspirations that motivate inventors and how they overcame significant challenges. We will continue research and programming on the topic of what factors – predictable, explainable, and occasionally ineffable – go into the making of an inventor and the web of connections – familial and institutional – that make their work possible. Looking also at innovation by small groups and even larger corporate research and development organizations, we can provide unique insights into the making of innovators.

Key questions to explore in future research and programming include: What can be done to increase individual curiosity? Can inventive thinking be taught and learned? Can innovation ecosystems, places that provide the right mix of people, incentives, acceptance of risk and failure, and financial supports be built intentionally to spur invention forward? How can governments be most effective in promoting invention and innovation? What approach to organizing corporate R&D – concentrated and closed-shop, or dispersed and open – has proven successful for different industries in different historical eras?

Building on the 2015 "Can Innovators Be Made?" workshop, the Center will investigate targeted questions about promoting innovation at the individual and societal levels. An edited volume from on the making of innovators is presently under development by Lemelson Center staff in collaboration with leading academics. In coming years, research, oral history interviews, and "Innovative Lives" programming will extend our biographical programming. Additional projects will be developed under the rubric of making innovators, including Spark!Lab-style activities (hands-on invention targeting specific questions or challenges) for adult audiences or inter-generational groups, and developmental or educational programs for professionals to become more innovative.

### **3. MATERIALS, COMPETITION, AND SPORT INNOVATIONS**

Participation in sports involves individual and team training and in many cases, competitions or other public displays of prowess. Sporting events measure and reward athletic ability, strategy, and skill. With professional, financial, and reputational stakes, participants are highly motivated to help develop and rapidly use innovations that will give them an edge. The Center has initiated a multi-year exploration of invention in sports, initially focused on skateboarding (Innoskate) and ancillary programs on surfing and other sports.

More extensive scholarly research and additional new programming on innovation in sports more generally will explore:

- the sources of invention and innovation in sports gear, performance-enhancing clothing, prosthetics, and other technologies;
- the relationship between new methods or techniques in sports and the material innovations; and
- tensions concerning fair competition and fear of reducing a sport to a technological arms race.

As a program topic, innovation in sports also can be a platform for studying new forms of participation and community building through the invention of new sports and novel sport (sub)cultures, including virtual competitions (e.g., live video gaming) and entirely new sports that capture public attention and participation. Importantly, this topic holds the potential to connect the Lemelson Center to new and more diverse audiences.

Research into several topics of contemporary concern will be strengthened by historical case studies and attention to long-term trends:

First, where does the athlete end and the technology begin? Boundaries between the body and new materials are renegotiated at distinction moments in history, and the distinction between the biological and the synthetic is presently shifting in light of inventions of new prosthetics and other human-technology interfaces.

Second, a new debate is emerging around the role of analytics and “big data” in sports. Do algorithms and greater use of computing reduce or make trivial the competition between people or teams? But predictive calculations have played a role in creating teams throughout history, so what has changed as a result of innovations in analytics?

Third, what are the implications of innovations in equipment that make sports more accessible to non-specialists and people with disabilities? Innovations in tennis and golf technology have expanded hitting surfaces; innovations in shaped skis have helped less skilled people tackle higher mountains, etc. At the same time, greater access to sports has made competition and healthier living available to people than in the past, including those with physical and mental disabilities. But do innovations in equipment encourage athletes

and the general public to take greater risks? Is a focus on competition necessary to broaden access and participation?

Fourth, do advances in knowledge about nutrition and other training approaches change core concepts of fitness and competition, or modify them in important ways? Long-distance runners now routinely train at high elevation to increase cardio-vascular capacity and virtual reality is becoming a common training tool across numerous sports. By contrast, inventions of performance enhancing drugs are widely understood to undermine the integrity of competition. What innovations have been foundational to the rise of extreme sports?

Fifth, sport provides a rich site for exploring the relationship between inventors and athletes who act as lead users, or to analyze the dual role of athletes who become inventors. Sporting competition at its highest level requires constant testing and trial of new technologies, materials, and ideas. Athletes and equipment designers are in frequent communication to create new inventions that provide a competitive edge. Often, the ideas and creation of new prototypes are generated by the athlete / inventor. In what ways are these processes similar or different from what the Lemelson Center has studied about inventors and their processes in other domains?

Innovation in sports and sport culture lend themselves to museum exhibitions, new public programs, and publications examining innovation in a domain that is drawing increasing scholarly attention. In addition, the Center will seek to enhance its visibility through the inclusion in program development of athletes and even professional teams.

#### **4. RISK AND FAILURE IN INVENTION AND INNOVATION**

Risk-taking by inventors and failures – whether considered dead-ends or helpful data on the path to success – are fundamental to the invention and innovation process. Beyond serendipity and chance, inventors operate on the boundary between the known and unknown and push beyond current knowledge and common approaches. Doing so involves risks to inventors ranging from the physical (an exploding laboratory) to the financial (failure to repay debts when inventions cannot be built or do not draw market interest). More broadly, risk is not just a pre-existing or natural hazard in the world that can cause injury, but instead is created by relations between humans and the technologies they create and can be tempered or managed by regulatory oversight. At times, efforts to regulate risk appear to strangle innovative sectors, but in other cases, regulation can provide significant incentives to invent new materials and methods.

More extensive scholarly research and new programming on risk and failure will explore:

- the individual and social dynamics of why some people are willing to take risks;
- when and why failed technologies lead to successes;
- what makes a final consumer product ‘work,’ whether it is inherently better technology, marketing, or other aspects of uptake by users;
- the role of national political culture and popular culture in invention and innovation; and
- how risk management shapes innovation, both as firms seek to meet regulatory mandates and as societies seek to protect themselves from risks generated in the course of industrialization and post-industrial economic growth.

Research addressing core questions concerning risk, failure, and innovation will involve historical study while also addressing issues of contemporary significance:

First, what role do risk-taking and failure play in the invention process? How do different inventors characterize the risks they take? What do they learn from failure?

Second, is risk a historical constant, or has it undergone significant change (e.g., in how it is managed and rewarded) between the late-18th century and today? In medicine, risk-taking and even innovation were considered taboo as recently as the mid-19th century. However, risk-taking in the pursuit of innovation has come to be seen as a noble even moral activity and was defined as particularly American. What led to this transformation in views about risk?

Third, what is meant by failure, and is this consistent over time, or has it been defined differently and held different implications in the past? Has the tolerance for failure changed over the past 150 years in ways that can be measured and analyzed? What forces condition responses by investors and the general public to inventors’ failures?

Fourth, what are the long-term economic and social implications of cultural differences in risk tolerance and variance in the support for failure in different sectors and between countries? If failure is seen as a badge of respect for entrepreneurs in ecommerce and biotechnology, how are similar events characterized elsewhere? What mechanisms for learning from failure exist in different sectors?

Beyond advancing scholarship, the role of risk and failure in innovation would form the intellectual basis for interesting exhibitions that would highlight inherent but often undervalued aspects of the invention process, with a larger educational message about how risk and failure are fundamental to learning. Attention to risk and failure also provide opportunities to reconsider famous inventors and draw attention to lesser known inventors or innovators. An exhibition could display objects associated with simultaneous invention, market competition, technological dead ends, and unintended consequences. We also could showcase extraordinary risks some inventors take in the process of their work, or display what are considered failed inventions adjacent to those considered successes to stimulate thinking about pathways not taken in the development and commercialization of technology.