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# AGENTS OF CHANGE: NSF'S ENGINEERING RESEARCH CENTERS

## A HISTORY

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# ENGINEERING RESEARCH CENTERS AGENTS OF CHANGE

The Engineering Research Centers (ERC) Program is the largest and most ambitious engineering program in the history of the National Science Foundation (NSF). Launched in 1984, this flagship program was aimed at strengthening the competitiveness of U.S. industry at a time when our postwar leadership in manufacturing and advanced technology was being threatened by emerging economies around the world.

From its outset, the goal of the ERC Program was to develop a new cross-disciplinary culture in engineering research and education, in partnership with industry, using a systems approach to advance knowledge and technology. This new culture would educate new generations of engineers who understood industrial practice and the process of advancing technology, so as to be ready to work productively in industry upon graduation. In other words, the goal of the Program was nothing less than revolutionizing engineering research and education in the U.S. to meet the challenges of a changing world.



# ERC HISTORY

## E-BOOK CONTENTS

The history of the ERC Program has now been told, written by longtime ERC Program leader Lynn Preston and communications consultant Courtland Lewis and published in August 2020. It is available, free of charge, as an online e-book.

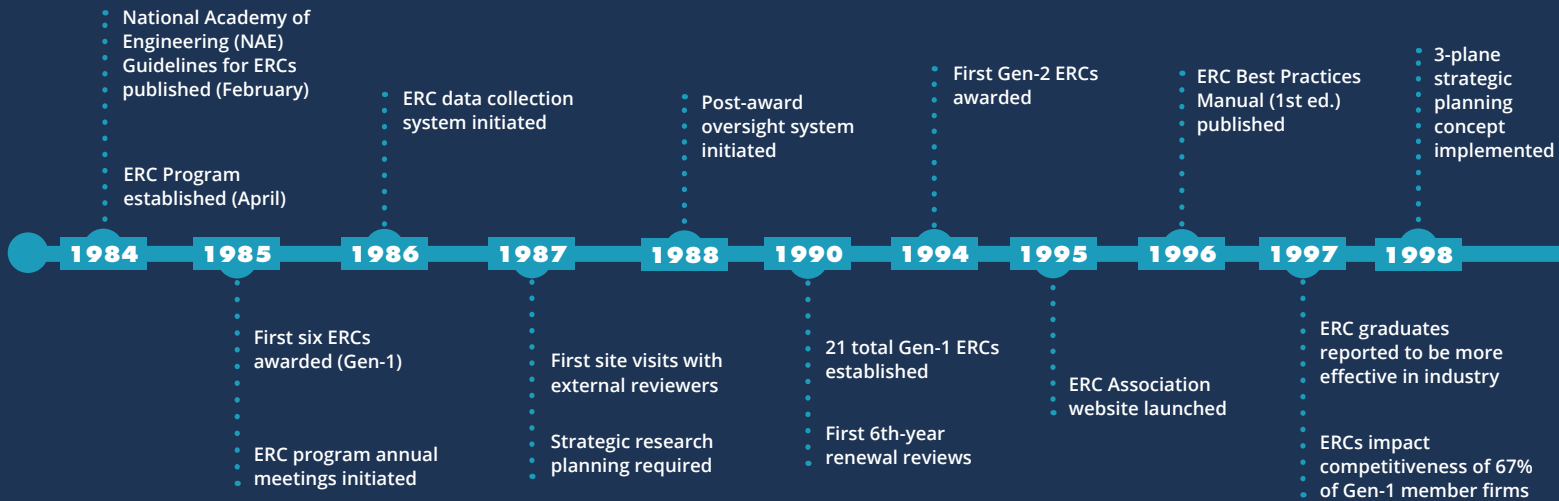
*Agents of Change: NSF's Engineering Research Centers* describes key achievements of the ERCs in terms of discoveries, technologies, and advances in education. The e-book provides a thoroughgoing and highly readable account of how the program has evolved continuously across decades to address the challenges and meet the needs of a changing world.

To read the in-depth story of this landmark NSF Engineering experiment, visit <https://erc-history.erc-assoc.org/>.

- Chapter 1** ERC Program Origins
- Chapter 2** ERC Program at Startup
- Chapter 3** ERC Generations -1 to -3: How they Evolved
- Chapter 4** University Perspective: Formulating, Operating, and Sustaining an ERC
- Chapter 5** Research
- Chapter 6** Industrial Collaboration and Advancing Technology
- Chapter 7** Education and Outreach Programs
- Chapter 8** Evolution of the ERC Leadership Teams and Post- ERC Careers
- Chapter 9** NSF Program Management
- Chapter 10** Major Impacts on Academic Engineering
- Chapter 11** Impacts on Engineering Research and Technology
- Chapter 12** Perspectives & Lessons Learned

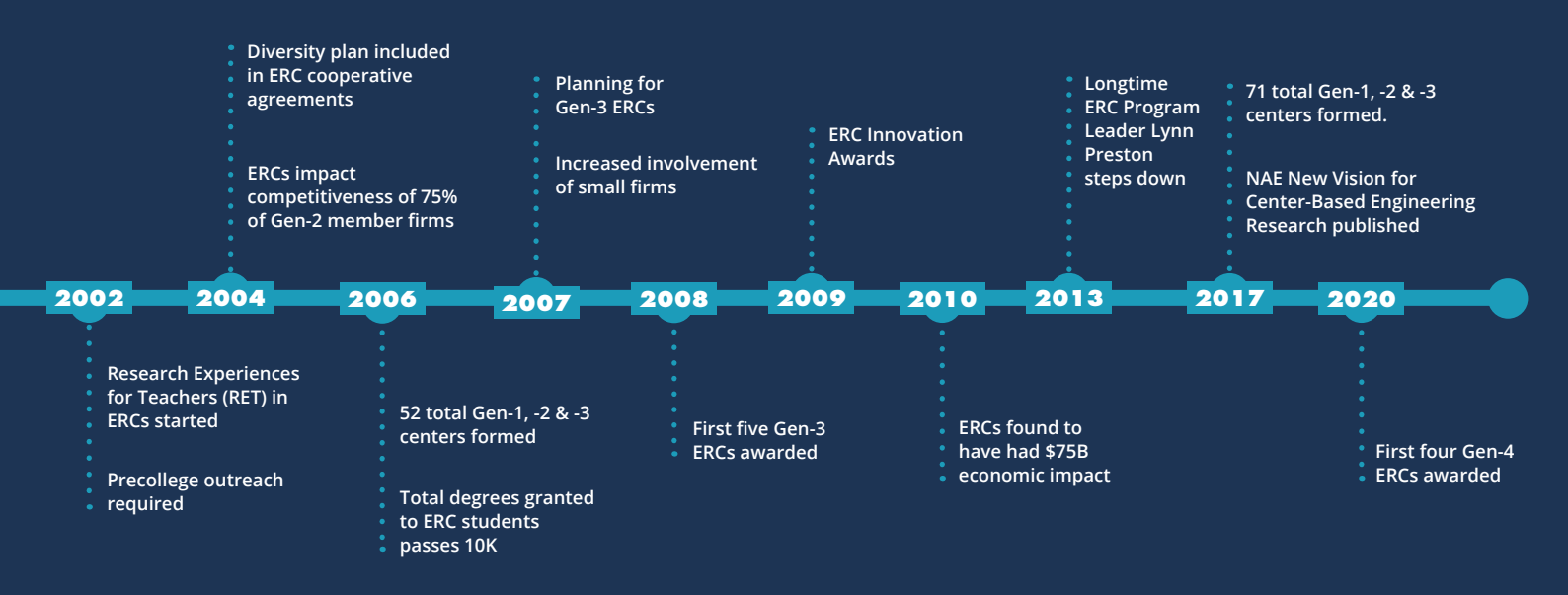
# A TIMELINE

## MAJOR MILESTONES & EVENTS IN ERC HISTORY



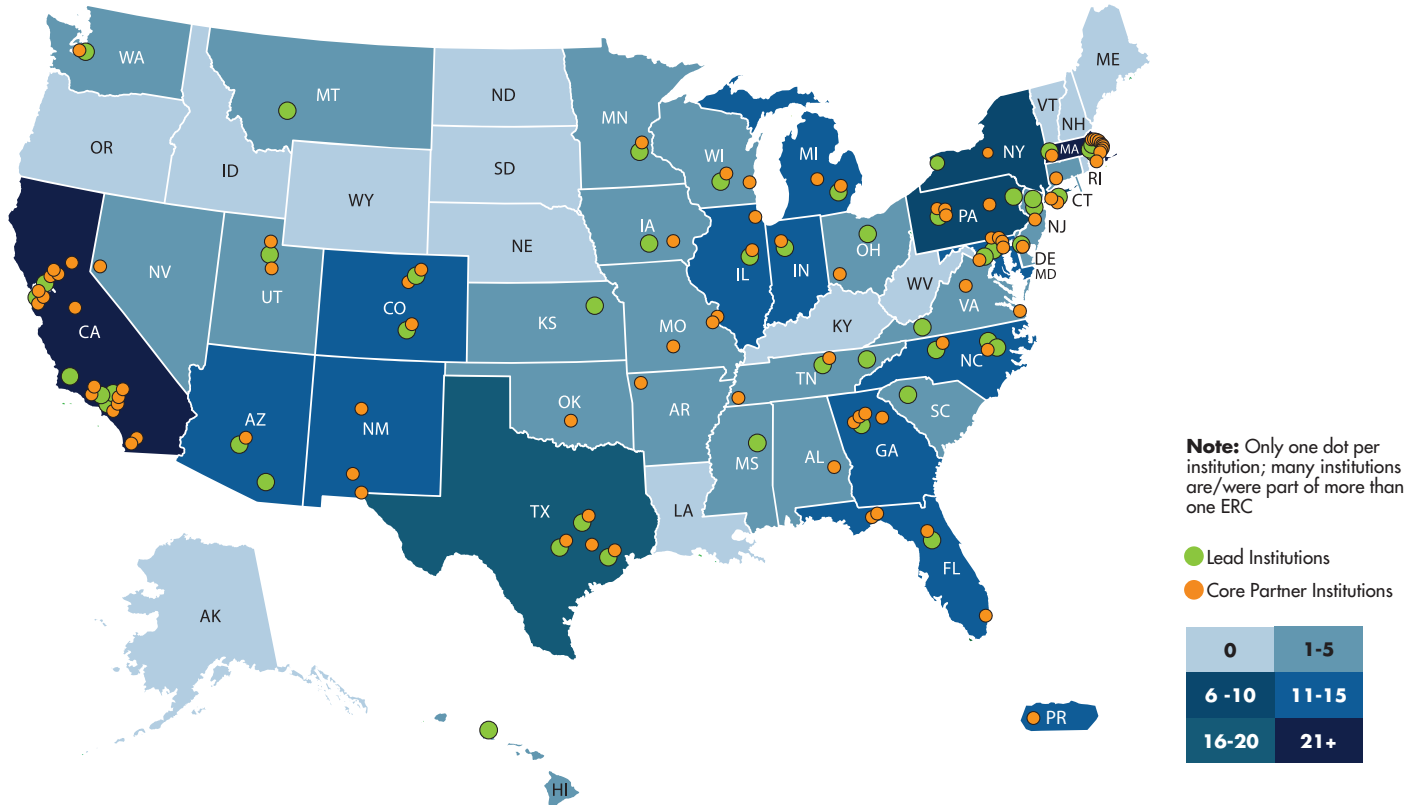
By 2020 there had been a total of 75 ERCs awarded—most of them multi-university centers. By 2020, 47 had successfully completed their 10-year term of NSF funding and of those 47, over 80% continue to be self-sustaining with many of their ERC features of research, education, and industrial collaboration still intact.





# NSF ENGINEERING RESEARCH CENTERS 1985-2020

## LEAD AND CORE PARTNER INSTITUTIONS



# INNOVATIONS AND IMPACTS

## ERC TECHNOLOGY TREE

The ERC Program has been the catalyst for advancing and even initiating a number of important new fields of technology, leading to hundreds of important innovations. A study conducted in 2010 found something on the order of \$75 billion in downstream economic value of ERC-developed technologies, not even counting hundreds of startup companies with thousands of employees, and thousands more graduates who have proven to be unusually effective in advancing technology and serving as leaders in globalized industry. Just some of these ERC-derived advances are illustrated here.

### ENVIRONMENT

- Biorenewable Chemicals
- Environmentally Benign Semiconductor Manufacturing

### ADVANCED MANUFACTURING

- Flexible/Intelligent Manufacturing
- Interfacial Engineering
- Nanomanufacturing Process Systems
- Cell Manufacturing
- Synthetic Biology
- Pharmaceutical Process Engineering

### ENERGY

- Solar Technologies
- Electric Energy Transmission Networks
- Combustion Engineering
- Offshore Technology
- Fluid Power

### INFRASTRUCTURE

- Earthquake Engineering
- Urban Water treatment
- Collaborative and Adaptive Sensors/Radars
- Integrated Building Systems

### BIOENGINEERING & HEALTH CARE

- Bioprocess Technologies
- Tissue Engineering
- Biofilm Engineering
- Robotic Surgical Systems
- Biological Engineering
- Biomaterials
- Self-powered Nano Health Systems
- Biomimetic Microelectronic Systems
- Neuroprosthetics

### MICROELECTRONICS

- Data Storage Systems
- Nanoscale Multiferroic Systems
- Integrated Electronics Packaging

### OPTOELECTRONICS

- Optical Access Networks
- Optical Signal & Image Processing
- Extreme Ultraviolet Sources
- Smart Lighting
- Surface Sensing & Imaging
- Mid-infrared Technologies

### COMMUNICATIONS

- Satellite-based Internet Access
- Immersive Media
- Lightwave Transmission Systems

# THE ERC FAMILY

Consistent, supportive management of the ERC Program across more than three decades produced the “ERC Family,” a cooperative, collective team undertaking of a kind that has seldom been seen in the history of government funding programs. Its highly diverse members ranged from NSF and Center leadership and staff to faculty and students, even including precollege students.







ENGINEERING  
RESEARCH  
CENTERS



ERC History E-book  
<https://erc-history.erc-assoc.org/>

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