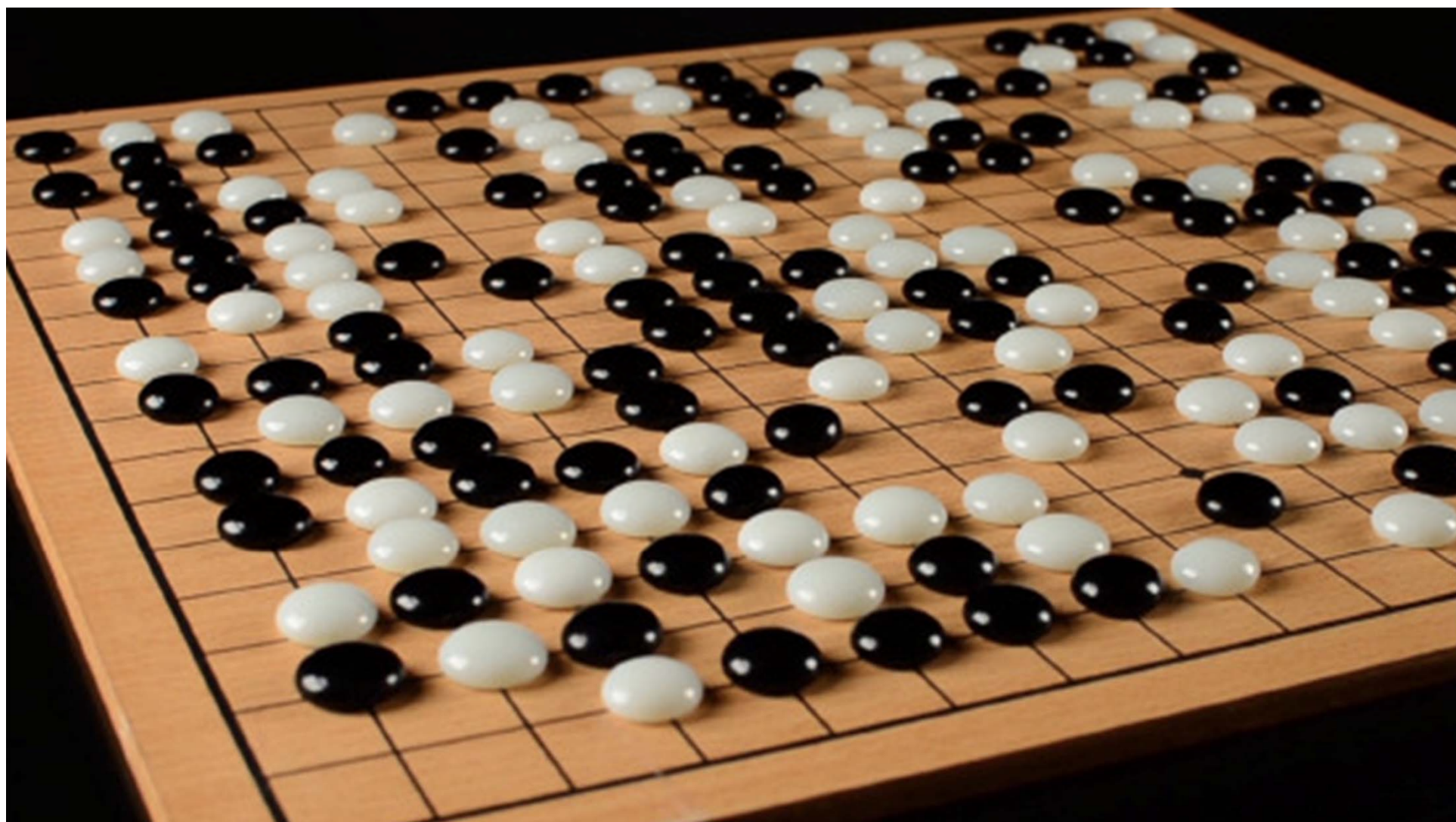


# The Second Machine Age

Andrew McAfee, MIT  
amcafee@mit.edu  
@amcafee

# Living in Exponential Times





# The Mystery of Go, the Ancient Game That Computers Still Can't Win

BY ALAN LEVINOVITZ 05.12.14 | 6:30 AM | PERMALINK

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**'I'LL SEE A MOVE AND BE SURE IT'S THE RIGHT ONE, BUT WON'T BE ABLE TO TELL YOU EXACTLY HOW I KNOW. I JUST SEE IT.'**

The trouble is that identifying Go moves that deserve attention is often a mysterious process. "You'll be looking at the board and just know," Redmond told me, as we stood in front of the projector screen watching Crazy Stone take back Nomitan's initial lead. "It's something subconscious, that you train through years and years of playing. I'll see a move and be sure it's the right one, but won't be able to tell you exactly how I know. I just see it."

**“We know more than we can tell”**

- Michael Polanyi

By **CHRISTOPHER CHABRIS**

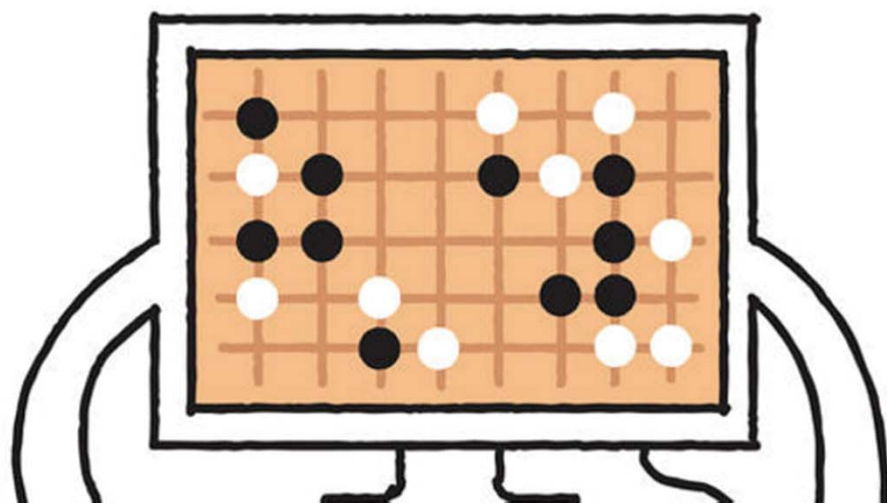
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## Why Go Still Foils the Computers

Facebook and Google are working to enable computers to play Go, an especially complex game that dates back more than 2,500 years





By [ALISTAIR BARR](#) and [JACK NICAS](#)

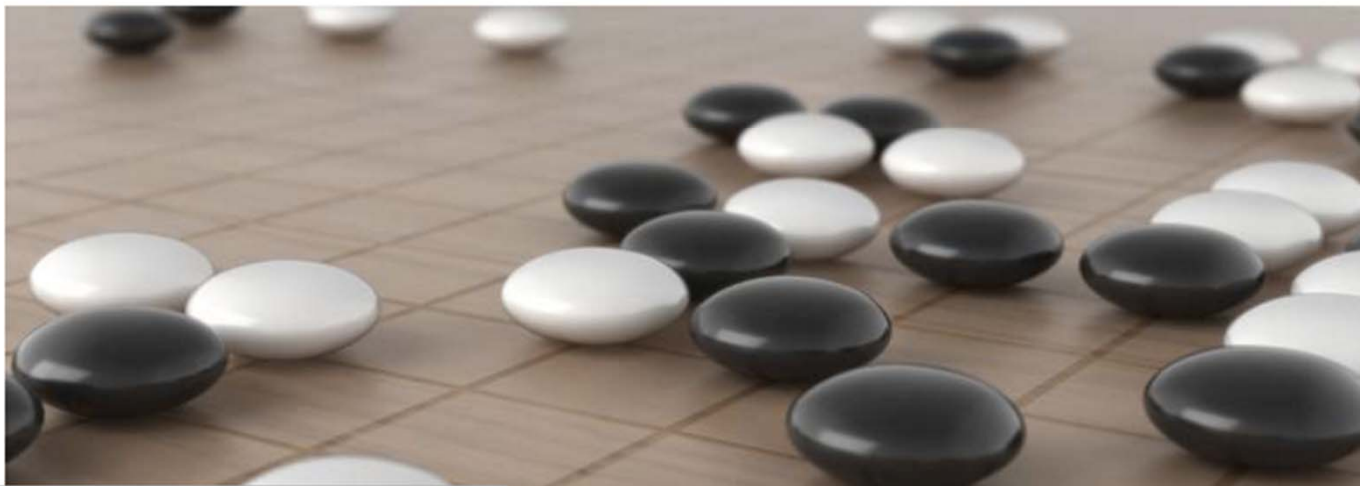
Updated Jan. 27, 2016 2:18 p.m. ET



TECH

## Google Parent Claims Artificial-Intelligence Victory in Go Game Win

Alphabet's AlphaGo beats top human player of Go game on full board, a milestone challenge



## ARTICLE PREVIEW

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# Mastering the game of Go with deep neural networks and tree search

David Silver, Aja Huang, Chris J. Maddison, Arthur Guez, Laurent Sifre, George van den Driessche, Julian Schrittwieser, Ioannis Antonoglou, Veda Panneershelvam, Marc Lanctot, Sander Dieleman, Dominik Grewe, John Nham, Nal Kalchbrenner, Ilya Sutskever, Timothy Lillicrap, Madeleine Leach, Koray Kavukcuoglu, Thore Graepel & Demis Hassabis

[Affiliations](#) | [Contributions](#) | [Corresponding authors](#)

Nature 529, 484–489 (28 January 2016) | doi:10.1038/nature16961

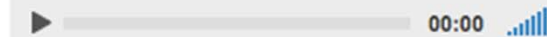
## Editor's summary

العربية

The victory in 1997 of the chess-playing computer Deep Blue in a six-game series against the then world champion Gary Kasparov was seen as a significant milestone in the development of artificial inte...

## Related audio

Hear from the makers of the AI that mastered Go - and the professional player it beat.

Authors with **Loop profiles** beta

Julian Schrittwieser

# American Go E-Journal

## AlphaGo vs Lee Sedol: Match schedule and details

Tuesday March 8, 2016

The much anticipated five game match between Lee Sedol 9P and Google DeepMind's AlphaGo begins this week Wednesday, March 9 (March 8 for American viewers). [Here is the match schedule](#), along with details of how you can watch and timezone conversions, courtesy [Go Game Guru](#).

The first game in the Lee Sedol-AlphaGo match will be Tuesday, March 8, 8p PST (11p EST). The match will be livestreamed on [DeepMind's YouTube channel](#) with English commentary by



DeepMind

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# Google's AlphaGo AI beats Lee Se-dol again to win Go series 4-1

By **Sam Byford** on March 15, 2016 05:00 am [✉ Email](#) [🐦 @345triangle](#)

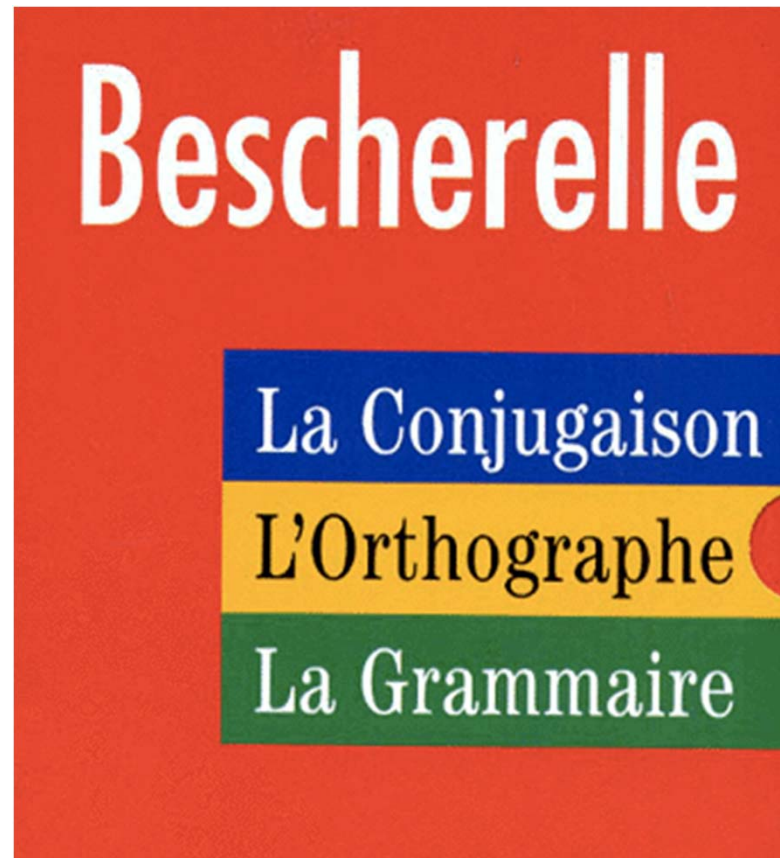


**Why is This Happening Now?**





# A Change in Approach

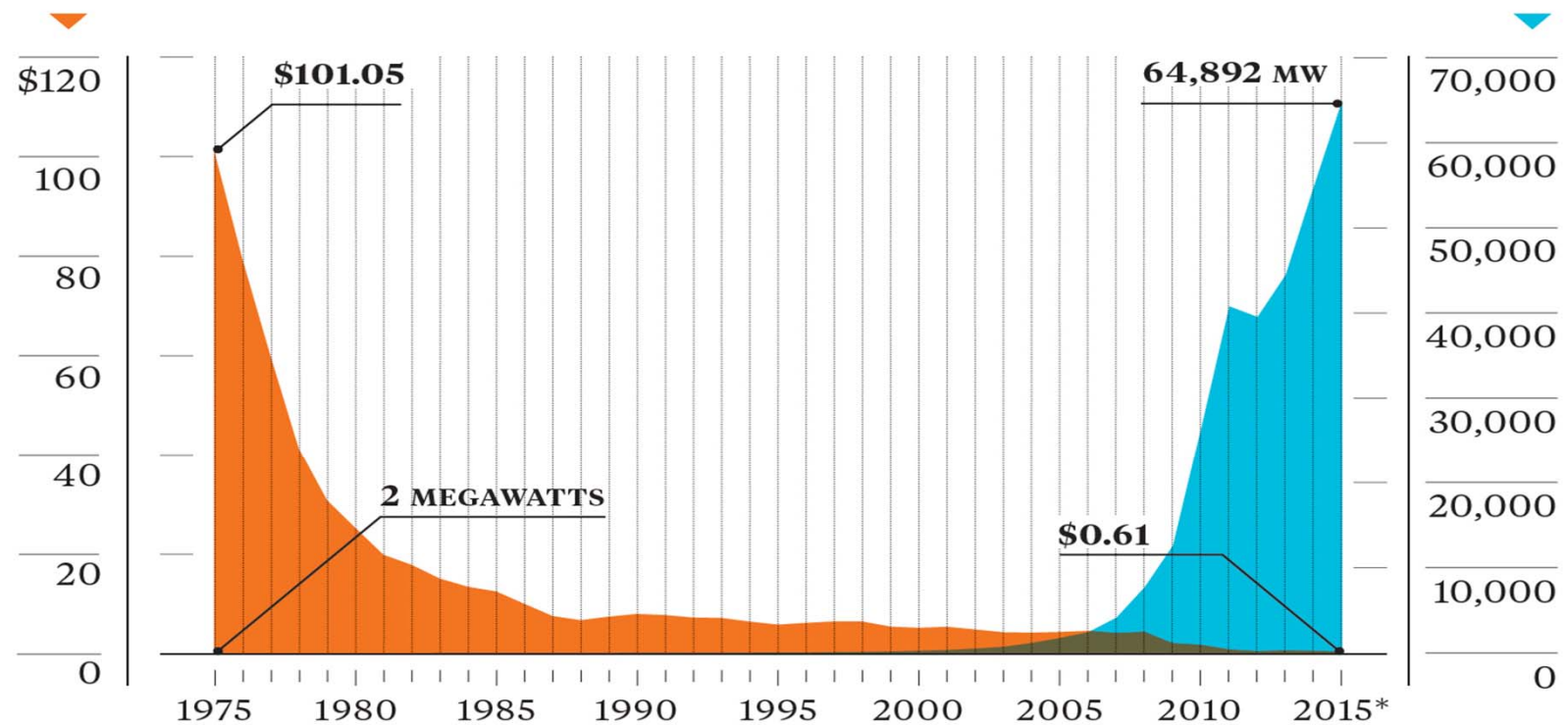


# Solar on Fire

As prices have dropped, installations have skyrocketed.

Price of a solar panel per watt

Global solar panel installations



\*Estimate. Sources: Bloomberg, Earth Policy Institute, [www.earth-policy.org](http://www.earth-policy.org)

# Google's Tensor Processing Unit Could Advance Moore's Law 7 Years Into The Future

from the Moore's-Law dept.

An anonymous reader writes from a report via PCWorld:

Google says its Tensor Processing Unit (TPU) [advances machine learning capability by a factor of three generations](#). "TPUs deliver an order of magnitude higher performance per watt than all commercially available GPUs and FPGA," said Google CEO Sundar Pichai during the company's I/O developer conference on Wednesday. The chips [powered the AlphaGo computer](#) that beat Lee Sedol, world champion of the game called Go. "We've been running TPUs inside our data centers for more than a year, and have found them to deliver an order of magnitude better-optimized performance per watt for machine learning. This is roughly equivalent to fast-forwarding technology about seven years into the future (three generations of Moore's Law)," said Google's [blog post](#). "TPU is tailored to machine learning applications, allowing the chip to be more tolerant of reduced computational precision, which means it requires fewer transistors per operation. Because of this, we can squeeze more operations per second into the silicon, use more sophisticated and powerful machine learning models, and apply these models more quickly, so users get more intelligent results more rapidly."

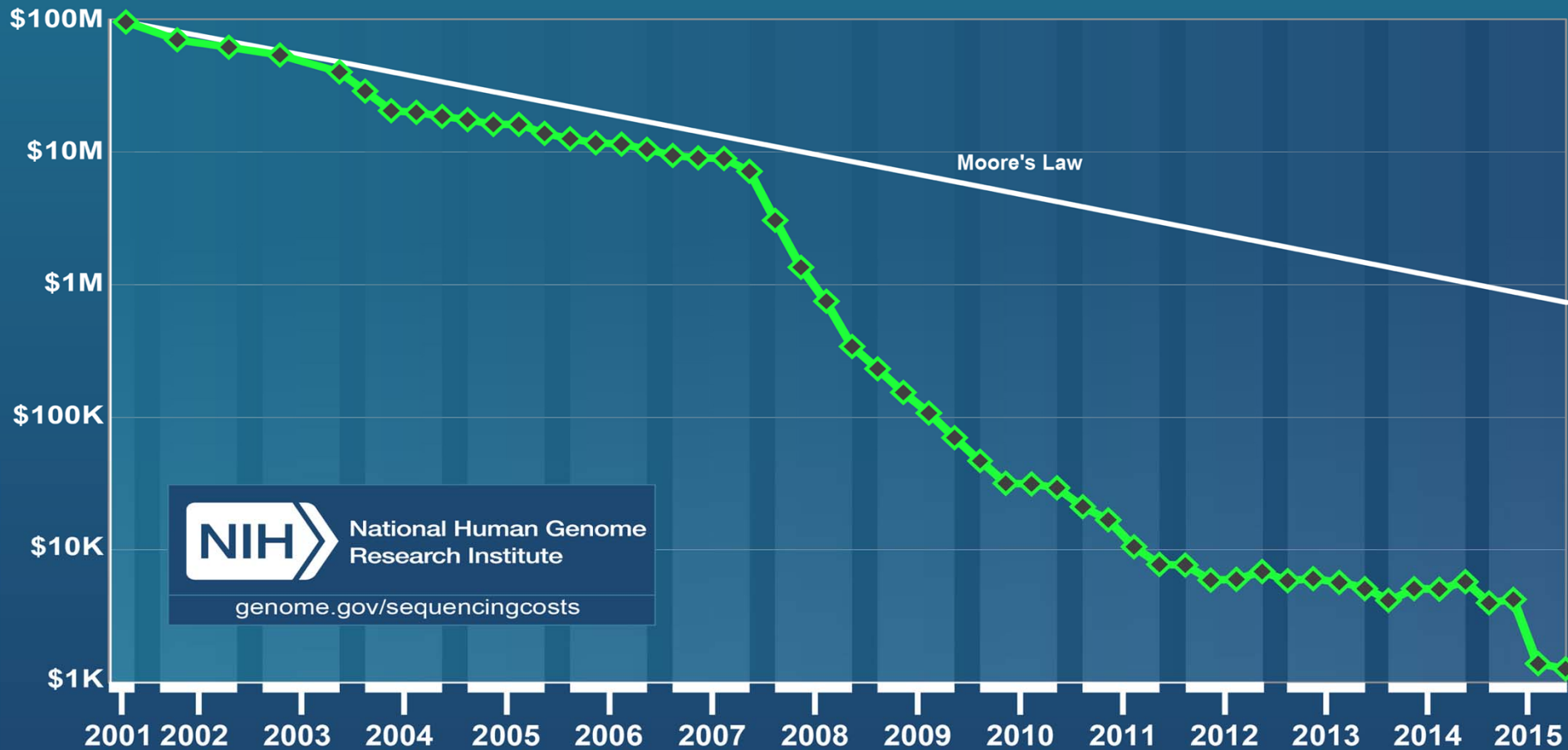
The chip is called the Tensor Processing Unit because it underpins [TensorFlow](#), the software engine that powers its deep learning services under an open-source license.

Posted by [BeauHD](#) May 18th, 2016 8:10PM

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Archived Discussion

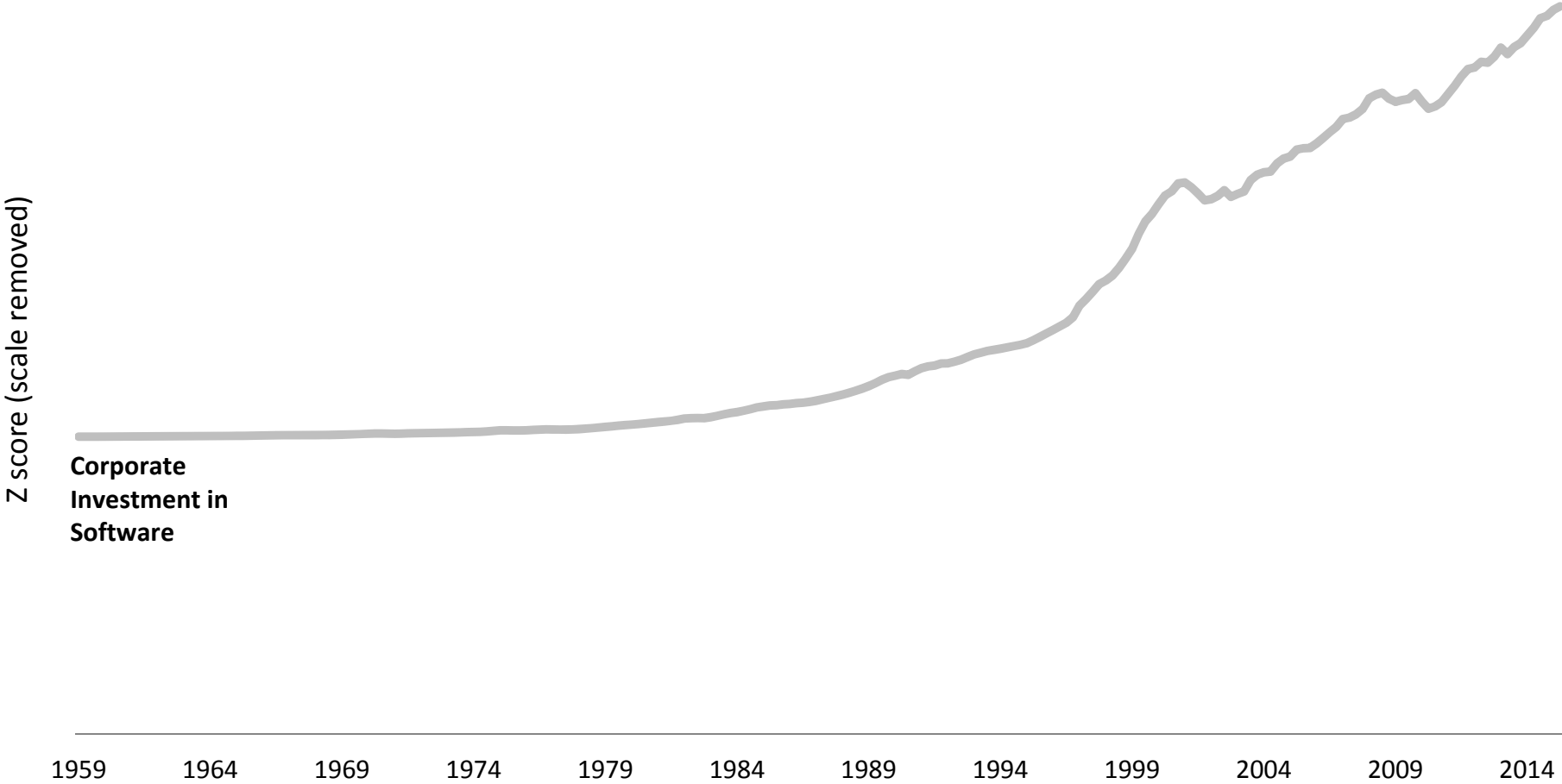
# Cost per Genome





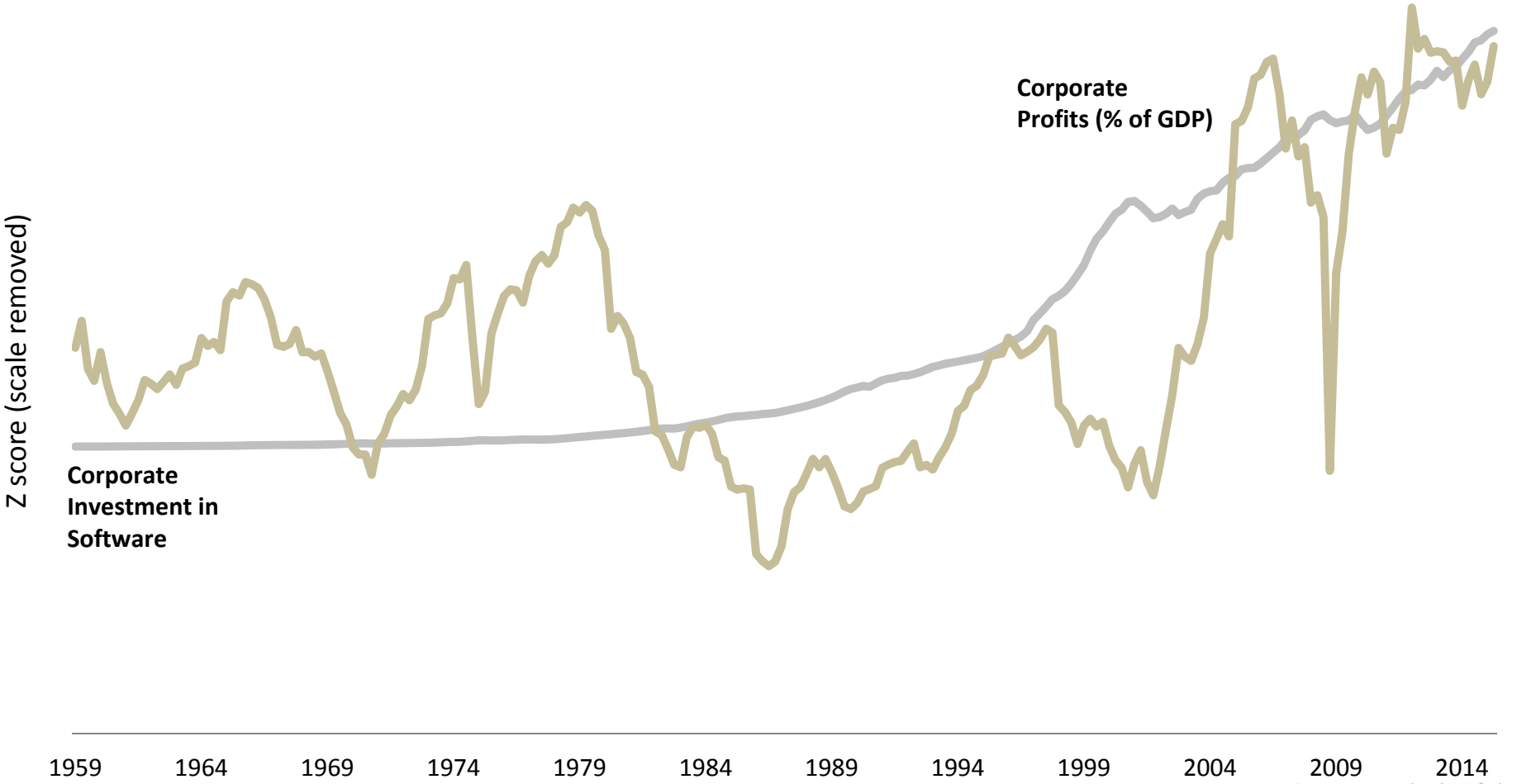
Implications for the economy and  
workforce

# Postwar Trends in the US Economy



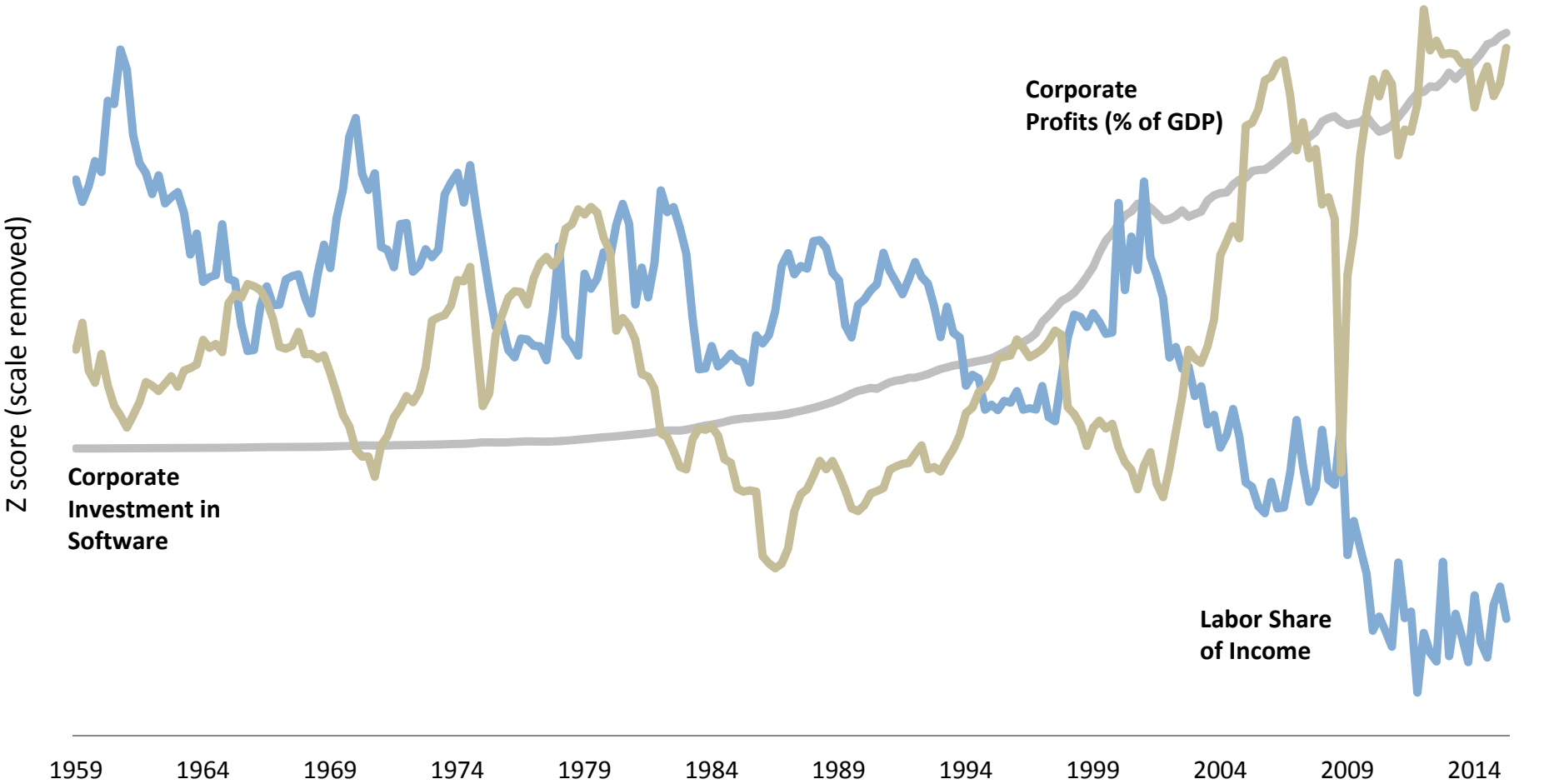
Source [research.stlouisfed.org](http://research.stlouisfed.org)

# Postwar Trends in the US Economy



Source [research.stlouisfed.org](http://research.stlouisfed.org)

# Postwar Trends in the US Economy

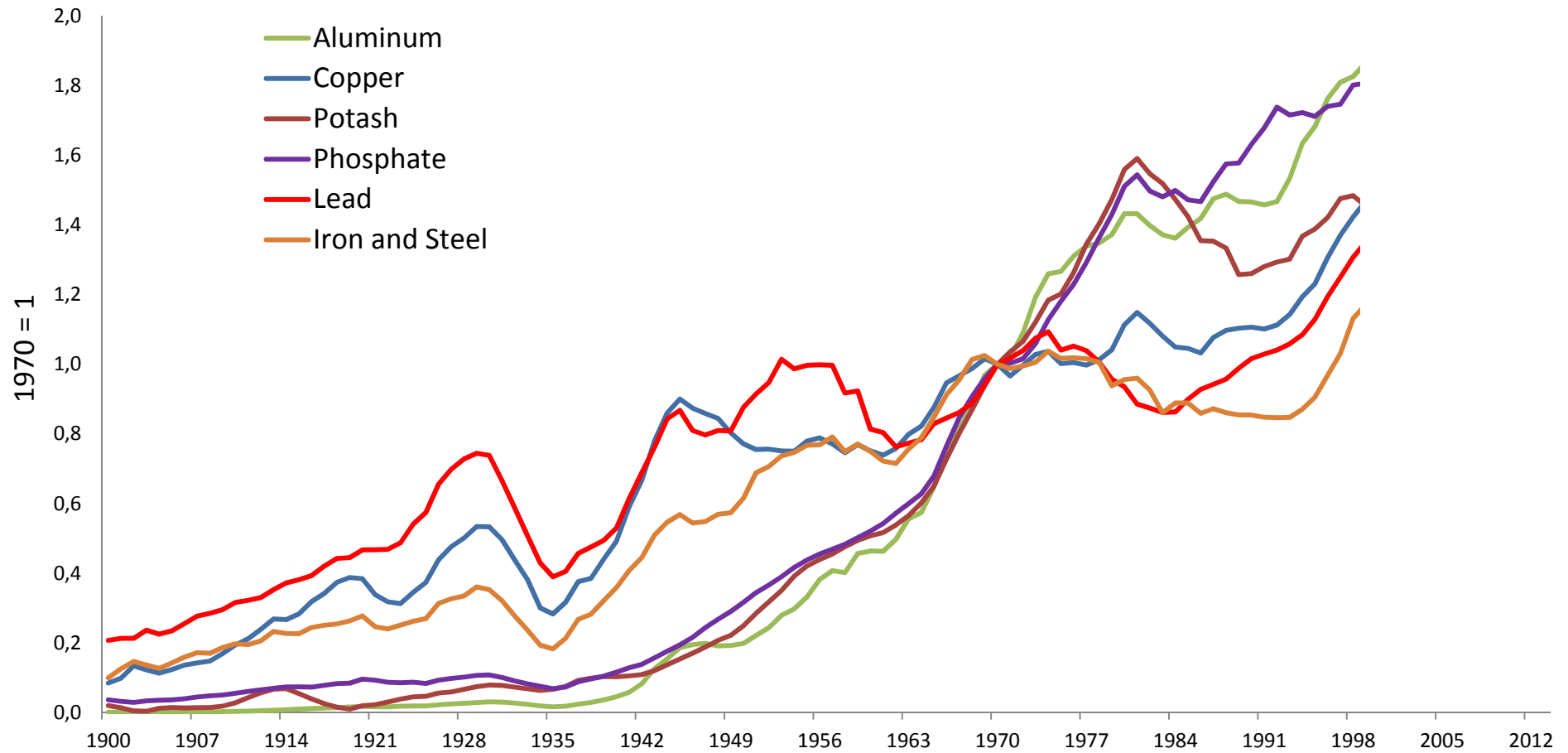


Source [research.stlouisfed.org](http://research.stlouisfed.org)



Implications for the planet  
Dematerialization (bits for atoms)

## Use of Basic Commodities in the US, 1900-2013



Source: Ausubel, "The Return of Nature"

**“We have tremendous challenges ahead of us. We have to improve the human condition around the world as the population grows while at the same time learning to tread more lightly on our planet. The only way we’ll meet them – and I’m confident that we will – is with a combination of technological progress, innovation, markets and goodwill.”**

LEARN MORE IN:

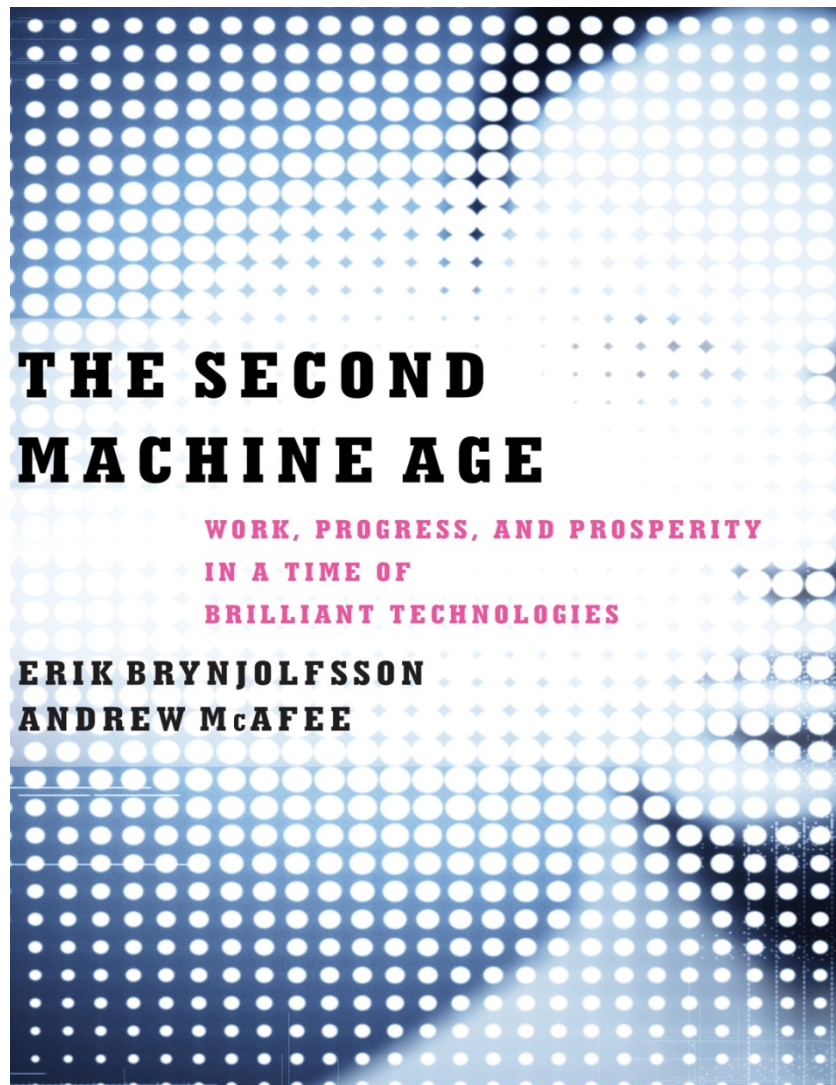
*‘Intelligent assets: Unlocking the circular economy potential’*

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ANDREW MCAFEE  
CO-DIRECTOR

MIT INITIATIVE ON THE DIGITAL ECONOMY &  
AUTHOR, THE SECOND MACHINE AGE



***Thank You!***

Andrew McAfee, MIT  
amcafee@mit.edu  
@amcafee