



Max Planck Institute
for Innovation and Competition

Economics of Innovation: Introduction

Dr. Rainer Widmann

Agenda

- Part I: The history of innovation:
 - The Industrial Revolution
 - The 20th century and beyond
- Part 2: Innovation and the market economy:
 - “Creative Destruction”
 - Firms’ incentives to innovate under competition



Part 1: The history of innovation

United Kingdom GDP per capita

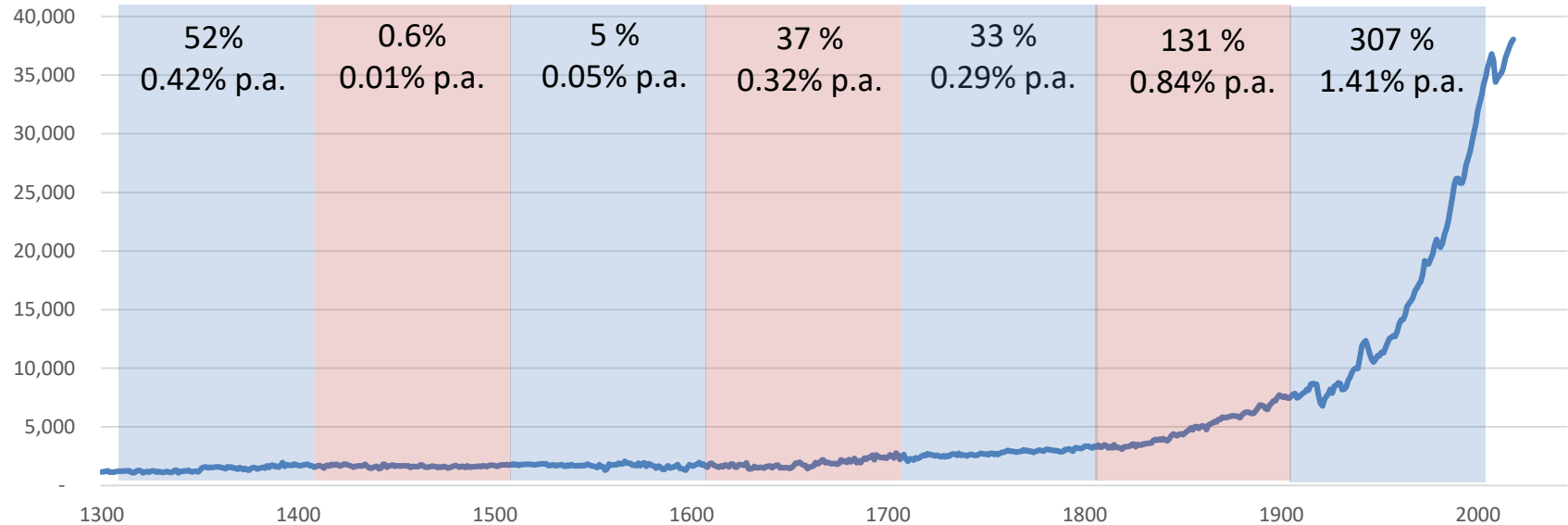


Notes: in 2011-US Dollar. Source: Maddison Project Database 2020



Part 1: The history of innovation

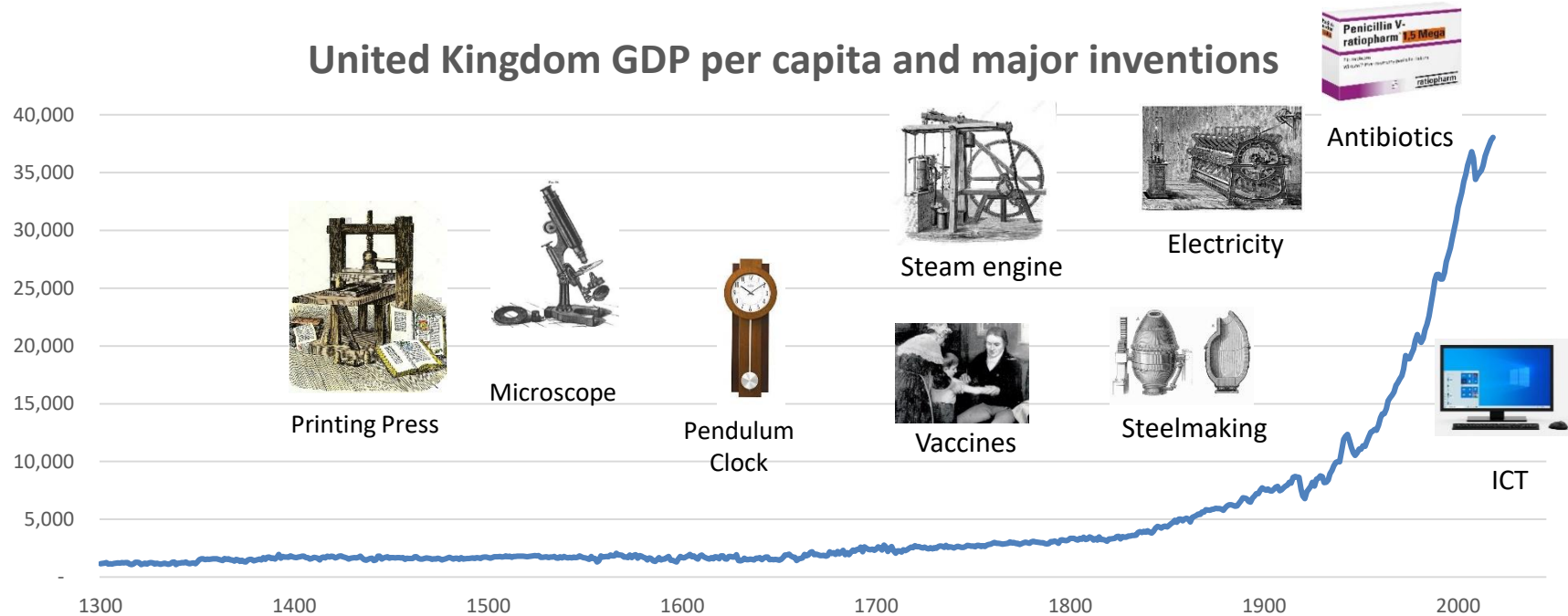
United Kingdom GDP per capita (Century growth and avg. per anno)



Notes: in 2011-US Dollar. Source: Maddison Project Database 2020



Part 1: The history of innovation



Part 1: The history of innovation

What explains the sudden explosion?

- „People overcame the tendency of accepting that techniques work without worrying about why they did so.“ (Mokyr 2004)

“Prescriptive Knowledge”:
what technique works?



“Propositional Knowledge”: what
are the natural regularities? why
does it work?

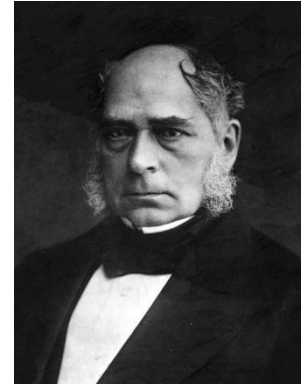
- “The narrower the propositional knowledge-base of a particular technique, the less likely it is to keep growing and expanding. Progress fizzles.” (cf. Mokyr 2004)
- Complex inventions (e.g. computer) do not occur by chance, but require many intermediate steps



Part 1: The history of innovation

An example: Bessemer Steel Making Process

- There was immense shortage of steel in Britain
- In 1856, Bessemer succeeds in producing steel from pig iron (and carbon) by oxidation
 - Realizes that that pig iron must be free of phosphor
- Study of metallurgy is established, others refine the process
- <https://www.youtube.com/watch?v=npp2t3aVZBc>

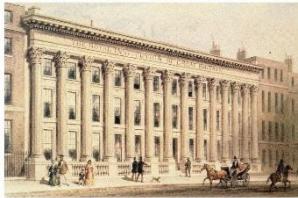


Henry Bessemer,
1813-1898

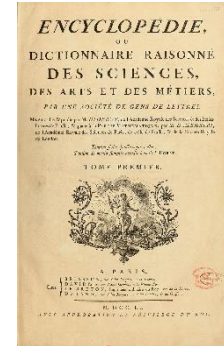
Part 1: The history of innovation

The First Industrial Revolution 1760-1850

- Techniques are **generalized** along expanding bases of knowledge
- Technical information and results are **disseminated**; Innovation becomes increasingly “**cumulative**”



The Royal Institute,
estbl. 1799



- Esp. Britain: conducive legal (and cultural) environment for private enterprise

Part 1: The history of innovation

The Second Industrial Revolution 1850-1914

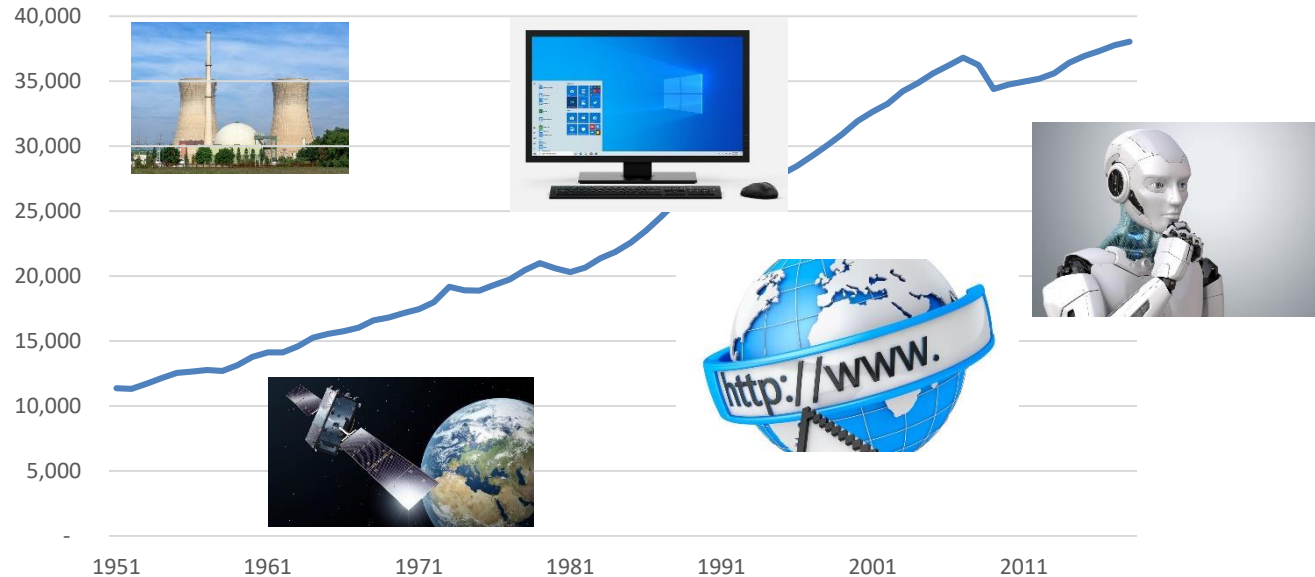
- The rise of “**Applied Science**” and “Research” in defined fields:
 - Organic Chemistry (plastics, fertilizer), Metallurgy (steelmaking), Electrical Engineering (telegraph), Bacteriology (food preservatives), Geology (mining)
 - Founding of **Technical Universities** (TUM: 1868)
- Other institutions co-evolve:
 - Finance: Stock Exchanges, Modern Banking, Accounting
 - Legal: Limited Liability Company
 - Political: Growing influence of industrial class



Part 1: The history of innovation

Fast forward to the second half of the 20th Century..

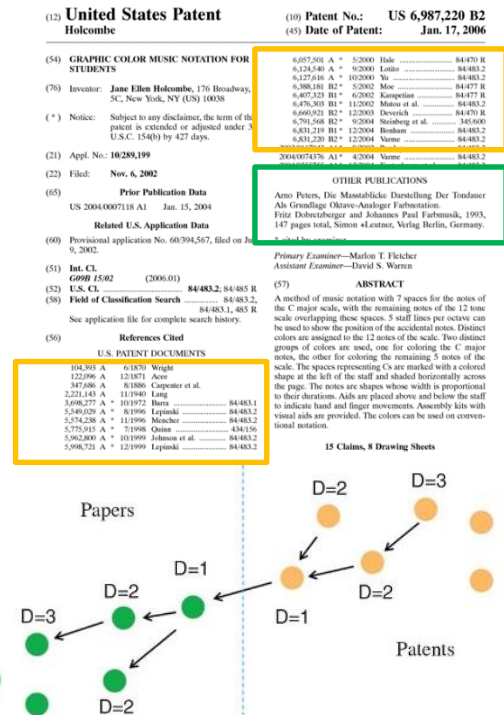
United Kingdom GPD per capita



Part 1: The history of innovation

M. Ahmadpour, B.F. Jones (2017, Science): “The Dual Frontier: Patented inventions and prior scientific advance”

- Calculate the **citation distance** from patents at the US patent office (applied 1976-2015) to scientific publications (published 1945-2013)
- They find that **>60% of patents can be connected** via a citation path to a publication

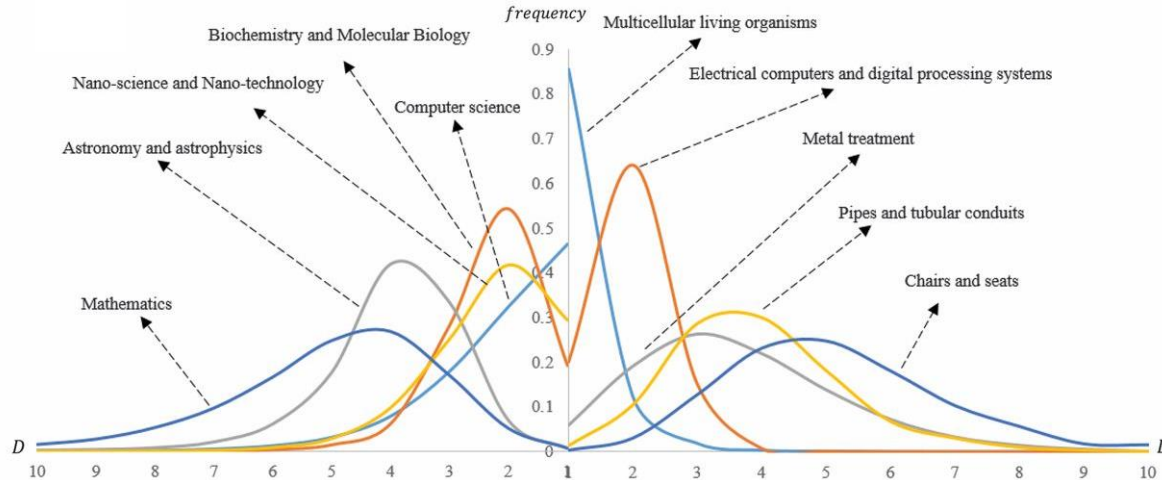


Part 1: The history of innovation

M. Ahmadpour, B.F. Jones (2017, Science): “The Dual Frontier: Patented inventions and prior scientific advance”

Citation-distance to the patent-publication frontier: Distribution by field

Scientific
publications



Patents



Part 1: The history of innovation

B.F. Jones (2009, Review of Economic Studies): “The Burden of Knowledge and the Death of the Renaissance Man: Is Innovation Getting Harder?”

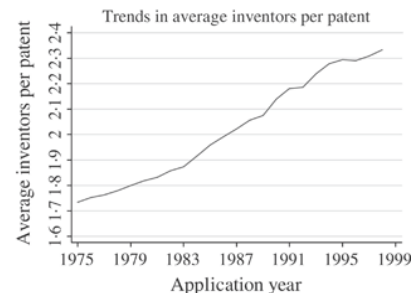
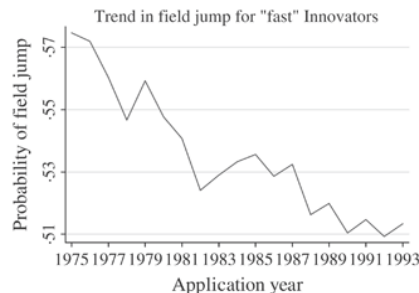
- If knowledge accumulates as technology advances, successive generations of innovators face an **increasing burden** -> cognitive limitations of the human mind may eventually limit further progress and economic growth
- Innovators may compensate by
 - lengthening the educational phase
 - narrowing their field of expertise
 - increasing reliance on team work



Part 1: The history of innovation

B.F. Jones (2009, Review of Economic Studies): “The Burden of Knowledge and the Death of the Renaissance Man: Is Innovation Getting Harder?”

- Data from inventors at the US patent office
- Trends in:
 - Age at first invention
 - Probability to change field
 - Number of inventors per patent



Part 2: Innovation and the market economy

Creative Destruction

- “At the heart of capitalism is creative destruction. [..]. [It is the] process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one.” (1942)
- Economic growth: innovation and imitation
 - Innovator becomes monopolist
 - Imitators enter, prices drop
 - New Innovator emerges etc.



Joseph. A. Schumpeter,
1883-1950



Part 2: Innovation and the market economy

Creative Destruction



Will MySpace ever lose its monopoly?

Victor Keegan

Thu 8 Feb 2007 07:41 EST



Taken from Henkel „Technology and Innovation Management“



Part 2: Innovation and the market economy

Characteristics of the market economy that facilitate innovation

- Economic Freedom:
 - Entrepreneurs (or economic agents) act on their knowledge and information
 - Consumers select which new technologies are useful
- Private Profits (net of taxes):
 - “add the fuel of interest to the fire of genius” (Lincoln 1849)
 - facilitate the acquisition of required resources (i.e. Finance).
- Competition:
 - “Innovation [...] becomes a life-and-death matter for the firm” (Baumol 2002)



Part 2: Innovation and the market economy

Firms' incentive to innovate

- Arrow 1962: consider an **incumbent monopolist that earns a profit of π**
 - If the incumbent innovates, it becomes a monopolist that earns $\pi' > \pi$
 - The highest cost that the incumbent is willing to incur for the innovation is $\pi' - \pi$



Part 2: Innovation and the market economy

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 - If the incumbent innovates, it becomes a monopolist that earns $\pi' > \pi$
 - The highest cost that the incumbent is willing to incur for the innovation is $\pi' - \pi$
- In contrast, **consider a firm that earns no profit** in the market (high competition between incumbents or the firm is an entrant)
 - If it innovates, it becomes a monopolist that earns π'
 - The highest cost that the firm is willing to incur for the innovation is π'



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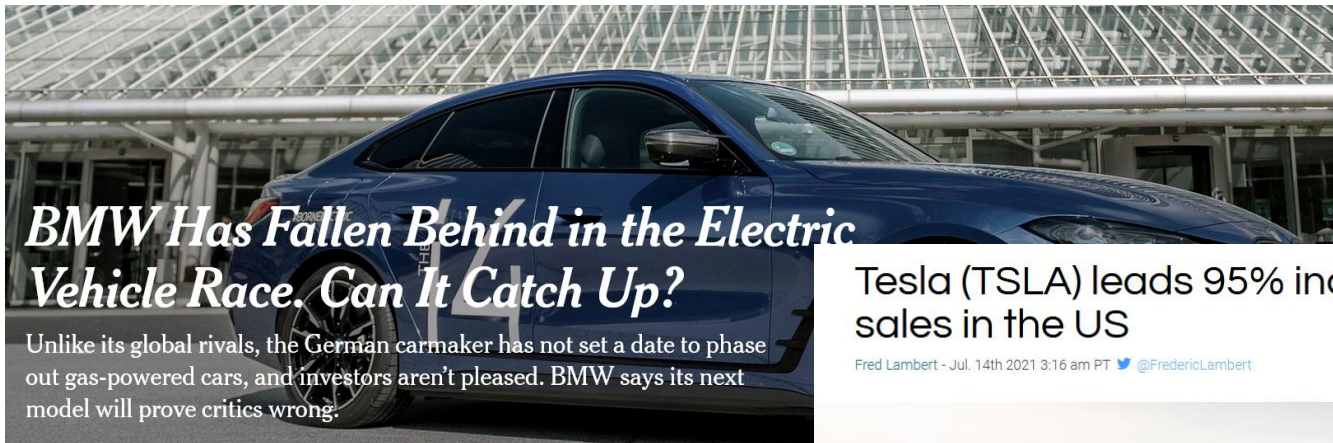
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➡ **The “Replacement Effect”: incentives to innovate are higher if there are lower pre-innovation profits that are being replaced**



Part 2: Innovation and the market economy

Firms' incentive to innovate: Entrants may be more innovative



Tesla (TSLA) leads 95% increase in electric car sales in the US

Fred Lambert - Jul. 14th 2021 3:16 am PT [@FredericLambert](#)



Part 2: Innovation and the market economy

Firms' incentive to innovate

- Gilbert and Newbery 1982: Consider an **incumbent monopolist that earns a profit of π^{mono}**
 - If it innovates, it earns π'^{mono}

In contrast, **consider an entrant firm that earns no profit**

- If it innovates, there is duopoly with the incumbent and it earns π''^{duo}

If the monopolist doesn't innovate, but the entrant does, it loses $\pi'^{mono} - \pi'^{duo}$



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➡ Since $\pi'^{mono} > \pi'^{duo} + \pi''^{duo}$, the monopolist's incentives to innovate are higher ("Preemption")



Detour: Why is the monopolist profit higher than the sum of duopoly profits?



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Duopoly in the market for smartphones

Apple

$\pi^{Apple\ duo}$

Samsung

$\pi^{Samsung\ duo}$

- The prices of both companies are set in a profit maximizing way at $p^{Apple\ duo}$ and $p^{Samsung\ duo}$



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Why? Suppose Sony raises the price of Apple phones marginally, starting at $p^{Apple\ duo}$.

Because $p^{Apple\ duo}$ was chosen optimally, the gains in per-unit-sold and the losses from lower sales exactly balance out and Apple's profit stays constant.



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However, sales losses of Apple increase Samsung's profit!



Part 2: Innovation and the market economy

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Part 2: Innovation and the market economy

Firms' incentive to innovate: Preemption is a powerful rationale

MARKETS ▼ **AMZN** \$3314.54 -6.14 0.18%

How Artificial Intelligence Will Power Amazon into 2021

CONTRIBUTOR

Tom Taulli — [InvestorPlace](#)

PUBLISHED

JAN 18, 2021 11:00AM EST



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Going into 2021, it seems like a really bad idea to bet against **Amazon** (NASDAQ:**AMZN**). That's because Amazon stock is likely to see continued growth powered by multiple secular trends, such as e-commerce, cloud computing and entertainment.



Source: Sundry Photography / Shutterstock.com

Microsoft invests \$1 billion in OpenAI to pursue holy grail of artificial intelligence

Building artificial general intelligence is OpenAI's ambitious goal

By [James Vincent](#) | Jul 22, 2019, 10:08am EDT



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Some of OpenAI's recent work has included improving robot dexterity. | Photo: OpenAI

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