



Army Science & Technology

Emerging Trends Report

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- 20190711



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SOLDIERS AS THE DECISIVE EDGE



- Trend Report started in 2013
 - Marilyn Freeman, DASA(R&T)
 - Synthesize data from multiple reports
 - Provided a strategic picture for senior leadership
- 2014-2016 reports
 - Trend cards – short one pager on each trend
 - Qualitative in nature
- Significant Changes
 - 2016 added contextual trends
 - Broad forces likely to shape the evolution of science and technology over the next 30 years
 - 2017 implemented a survey to help determine US position in trends
 - 2018 changed to more quantitative data to better assess US position in the identified emerging trends





2018 Trend Card

QUANTUM COMPUTING

Long-hyped as an emerging revolution, quantum computing has been slow to show practical applications. That has begun changing rapidly, with companies in Canada, the US, Europe, and China demonstrating quantum computers that approach what IBM has referred to as "quantum dominance" - the point at which a quantum computer exceeds the performance of any classical computer. Quantum computers could transform drug discovery, enable simulations of novel materials for batteries, and lead to impervious encryption. On the other hand, the U.S. National Academy of Sciences estimates that traditional encryption schemes could be quickly cracked by a quantum computer.



EMERGING CAPABILITIES

» Quantum Key Distribution

Researchers in South Korea demonstrated the first quantum key distribution (QKD) in daylight. The system achieved a secure key transmission rate of 142.94 kbps with a quantum bit error rate of 4.26% in daylight over a distance of 275 meters.

» Quantum Metrology

China is opening a \$10 billion National Laboratory for Quantum Information Science in 2020 that will focus on applied quantum computing and quantum metrology (using quantum effects to measure minute changes in gravity, mostly for position, navigation, and timing applications).

» Quantum Communications

In 2016, China launched the first satellite dedicated to testing quantum communication. In 2018, Chinese scientists used this satellite to distribute entangled photons to pairs of ground stations in China up to 1200 km apart. This represents a major breakthrough in secure quantum communications.

TOP INSTITUTIONS BY ACADEMIC PUBLICATIONS, 2014-2018

| Institution | Country | # of Publications |
|---|-----------|-------------------|
| Chinese Academy of Sciences | China | 1,088 |
| CNRS Centre National de la Recherche Scientifique | France | 879 |
| University of Science and Technology of China | China | 796 |
| National University of Singapore | Singapore | 556 |
| University of Waterloo | Canada | 543 |

TOP PATENT HOLDERS, 2014-2018

| Institution | Country | # of Patents |
|--|---------|--------------|
| Intel Corporation | USA | 88 |
| D-Wave Systems | Canada | 82 |
| Toshiba Corporation | Japan | 76 |
| Shenzhen China Star Optoelectronics Technology Company | China | 69 |
| IBM | USA | 59 |

Based on priority applications and grants filed with the USPTO, EPO, IPO, or WIPO.

TOP VENTURE CAPITAL DEALS, 2018

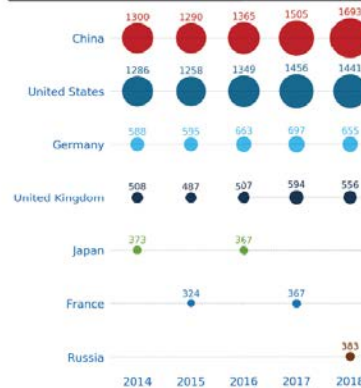
| Organization | Country | Last Deal (\$MM) | Deal Type |
|-------------------|---------|------------------|-----------|
| D-Wave Systems | Canada | \$10 | Grant |
| ISARA Corporation | Canada | \$10 | Series A |
| Xanadu | Canada | \$6.9 | Seed |
| ColdQuanta | USA | \$6.8 | Seed |
| QC Ware | USA | \$6.5 | Series A |

S&T EMERGING TRENDS REPORT, 5th EDITION

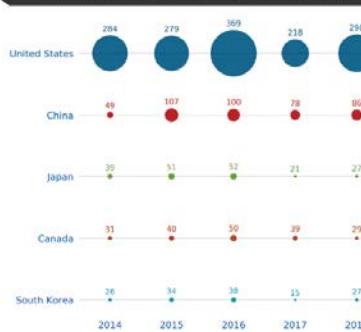
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TOP COUNTRIES BY ACADEMIC PUBLICATIONS, 2014-2018



TOP COUNTRIES BY PATENTS GRANTED, 2014-2018



\$2.8 billion

IN VENTURE CAPITAL 2018

13%

COMPOUND ANNUAL GROWTH 2014-2018

Patent and Publication data vs time: indicates growth in topic and countries leading publication and patent production

State of the Art and Emerging Capabilities: gives reader an idea of where the technology currently stands and where it is heading.

Top Publication Institutions and Patent Holders

Top Venture Capital Deals of 2018: Denotes company, country, amount and deal type





2017/2018 Report Results

• Top Trends for 2017 and 2018

| 2017 | 2018 |
|---|---|
| Robotics, Artificial Intelligence, and Automation | Robotics, Artificial Intelligence, and Automation |
| Advanced Materials and Manufacturing | Advanced Materials and Manufacturing |
| Energy Production, Harvesting, Storage and Distribution | Energy Production, Harvesting, Storage and Distribution |
| Biomedical Science and Human Augmentation | Biomedical Science and Human Augmentation |
| Quantum Computing | Quantum Computing |
| Synthetic Biology | Synthetic Biology |
| Mixed Reality and Digital Mimicry | “Digital Reality” technologies, including mixed reality and the rise of “deepfakes” |
| Food and Water Security Technologies | Technologies for Food and Water Security |
| Climate Change Adaption Technologies | Technologies for Improving Resilience of Cities |
| Space Technologies | Cybersecurity, and Technologies related to Digital Privacy and Trust |



2017/2018 Report Results

- Top Contextual Trends for 2017 and 2018

| 2017 | 2018 |
|---------------------------------|---|
| Urbanization | Growth of Dense Urban Environments |
| Resource Constraints | Increasing Threat of Resource Constraints |
| Globalization of Innovation | Shifting Landscape of Global Innovation |
| Shifting Demographics | Growing Complexity of Cybersecurity and Protection in the “digital commons” |
| Climate Change | |
| Rise of the Global Middle Class | |

- Major take aways from 2018 contextual trends

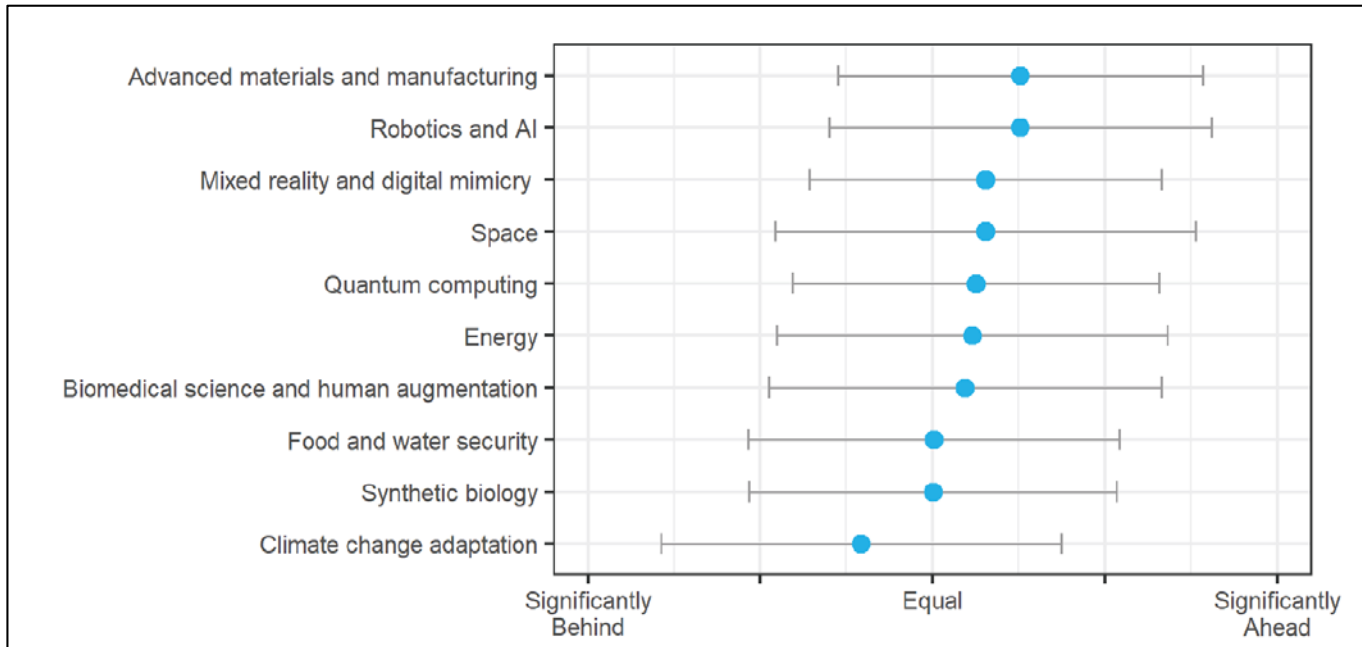
- Army likely to find itself operating in and around dense Urban Environment
- Future conflicts likely to arise over limited natural resources
- US highly unlikely to maintain its dominance in global innovation
- Cybersecurity will become an increasingly strong driver of R&D





Qualitative vs Quantitative

- With the increase in Globalization, the question starts to arise is where does the US stand in these emerging trends
- In 2017, surveyed Subject Matter Experts on where the US stands compared to rest of world



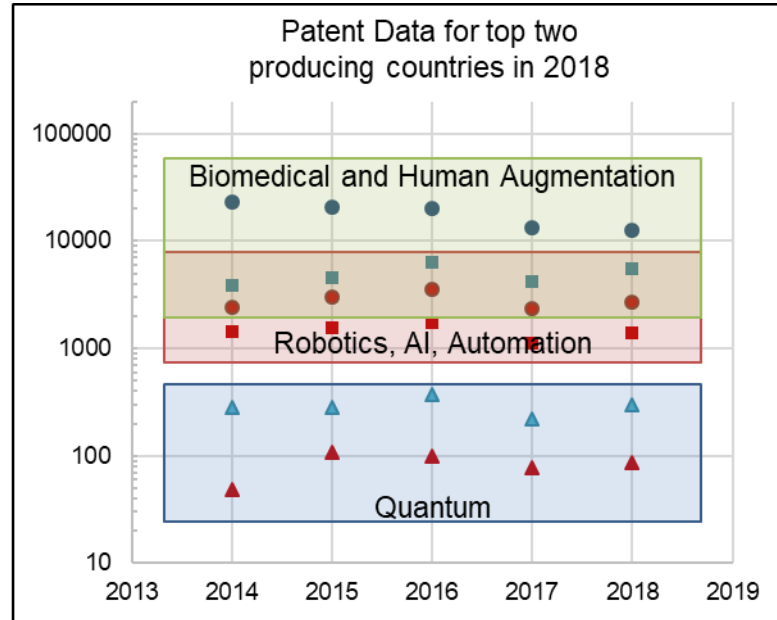
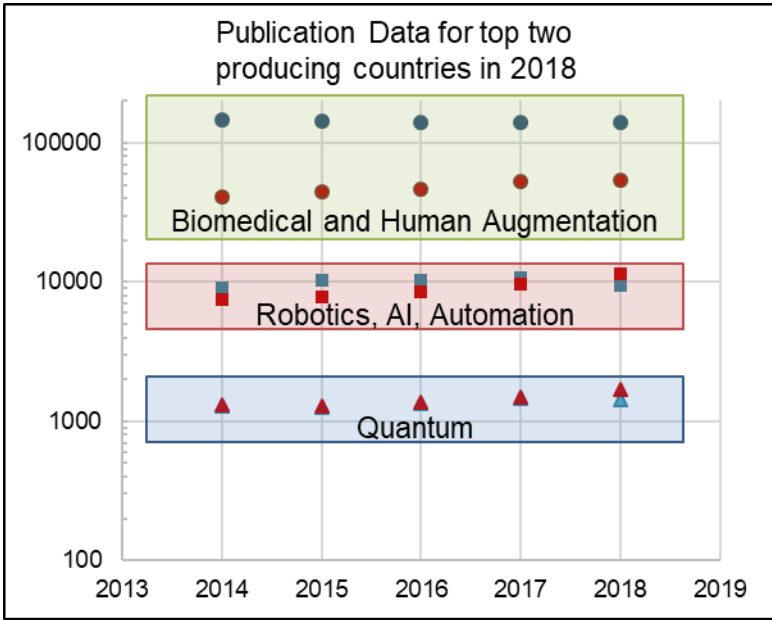
- As seen above, in general the US SMEs felt that the US was equal or ahead in almost all areas





Qualitative vs Quantitative

- After the 2017 report, further analysis was done for 2018, this time looking at more quantitative numbers, such as publications*, patents*, and venture capital funds**



● ■ ▲ - US
● ■ ▲ - Next top producing country

** The top two countries for 2018 were chosen to highlight closing gaps

* Sources can be found in the actual report

- Log scale chosen for plots to help clarity

| Quantum | | |
|-------------------|---------|-----------------|
| Organization | Country | Last Deal (\$M) |
| D-Wave | Canada | \$10 |
| ISARA Corporation | Canada | \$10 |
| Xanadu | Canada | \$6.9 |
| ColdQuanta | USA | \$6.8 |
| QC Ware | USA | \$6.5 |

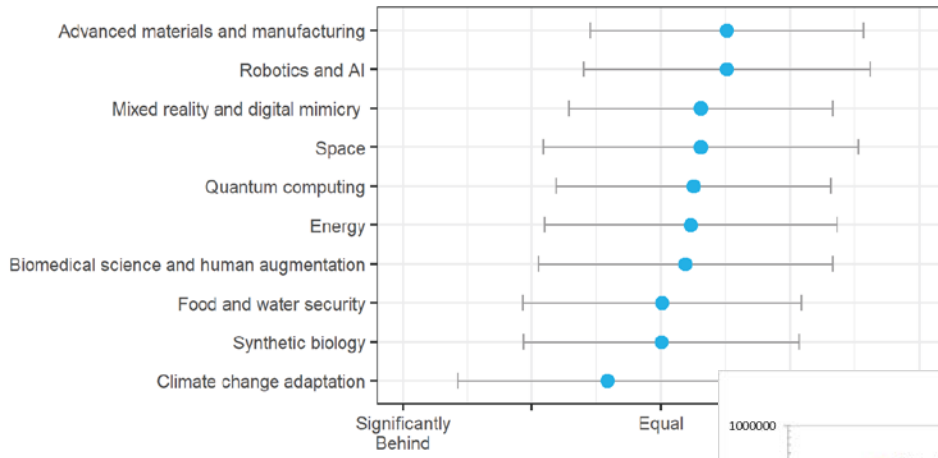
| Robotics, AI, Automation | | |
|--------------------------|---------|-----------------|
| Organization | Country | Last Deal (\$M) |
| Cruise Automation | USA | \$3,350 |
| ByteDance | China | \$3,000 |
| SenseTime | China | \$1,000 |
| UBTech Robotics | China | \$820 |
| Xiaopeng Motors | China | \$585 |

| Biomedical Science and Human Augmentation | | |
|---|-------------|-----------------|
| Organization | Country | Last Deal (\$M) |
| Samsung Bioepis | South Korea | \$668 |
| Magic Leap | USA | \$461 |
| Samumed | USA | \$438 |
| Zymergen | USA | \$400 |
| Relay Therapeutics | USA | \$400 |

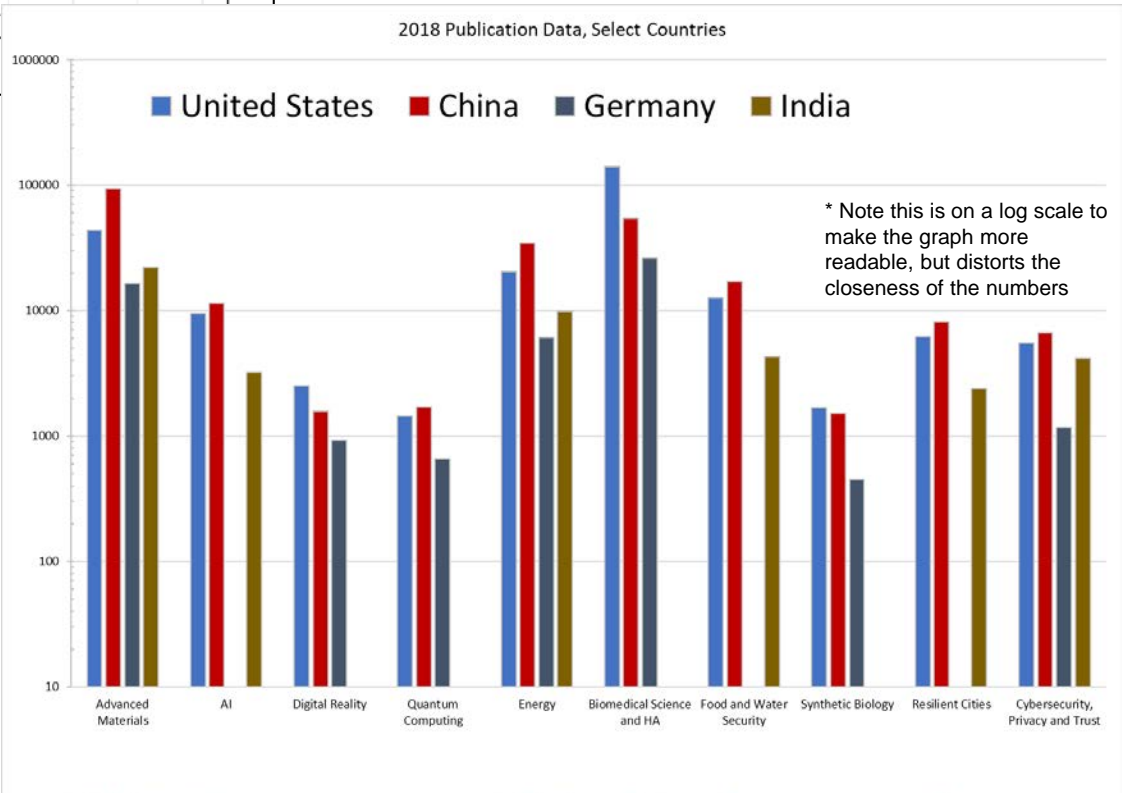


Qualitative vs Quantitative

2017 US SME Opinions



2018 Publication Data



Comparing the two charts, it is easy to identify several areas where the US SMEs rated the US ahead of the world, but publication data suggests otherwise.





Future

- 2019 Report
 - Likely just an update as the 2018 version was delayed due to the new changes
 - Will continue the trend cards with the quantitative analysis
- Future of report uncertain after 2019
- Other activities sponsored by our office
 - Predictive Analytics
 - Crowd Sourced Wargaming





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Questions



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