

# "Managing Technology in an Increasingly Unmanageable World"

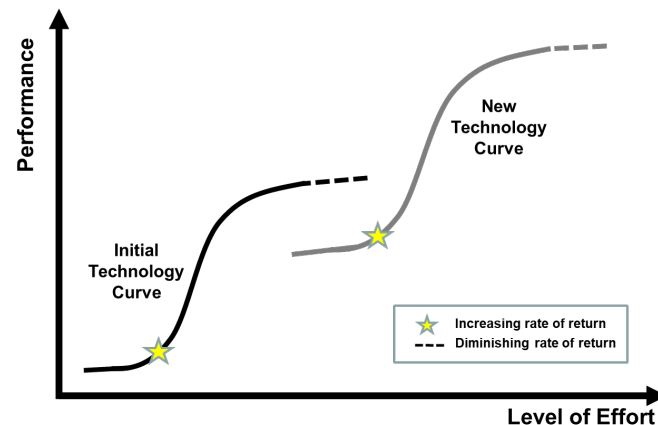
*Implications for US Security and Defense*

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# The Environment--Some Conclusions About Technology

- ❑ History of humankind and technology are inextricably intertwined
  - Technologies are collections of other technologies
  - We are seeing a convergence of technologies
- ❑ Greater technological capacity and reach than ever before
  - Inherently dual use, highly democratized and increasingly disruptive
- ❑ The S-Curve provides a way to think about technology development
  - But does the S-curve still adequately capture convergent technologies?



# Trend #1 – We Constantly Conflate the Terminology Causing Confusion

## Science & Technology

- ❑ Science
  - Derivation
    - Greek meaning “true sense”
    - Latin scientia, which means “knowledge”
    - Old French meaning “knowledge, learning, application”
  - Definition:
    - the pursuit of knowledge and understanding of the natural and social world following use of a systematic (or scientific) method
- ❑ Technology
  - Derivation:
    - Greek often translated as “craftsmanship,” “craft,” or “art”
  - Definition:
    - the application of capabilities for practical purposes

## Research & Development

- A structured process that derives from the Industrial Revolution
  - Modern R&D system emerges in the middle of 20th century
- Purposeful activity designed to result in attainment of new capabilities for an operational or economic purpose
  - Industrial process, including production, manufacturing, and procurement (or acquisition)
- Technology Readiness Levels (1-9)
  - TRL1-3    Research
  - TRL 3-7    Development
  - TRL 8-9    Lifecycle Support

## Innovation & Transformation

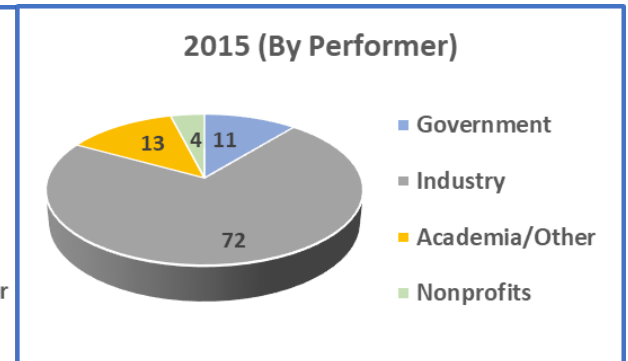
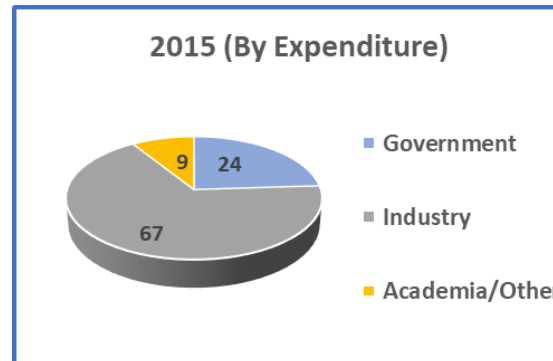
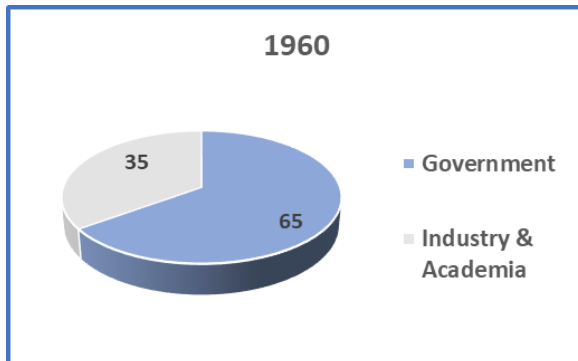
- Innovation
  - Incorporates new ways of thinking and novel ideas
  - Gaining effectiveness and efficiencies
- Transformation
  - Describes comprehensive organizational change
  - Can occur in any organization, industry, or government
  - However, the term owes a significant portion of its popularity to its use (some might say overuse) by the US military

# Trend #2 -- Continuing Shifts in Technology Development

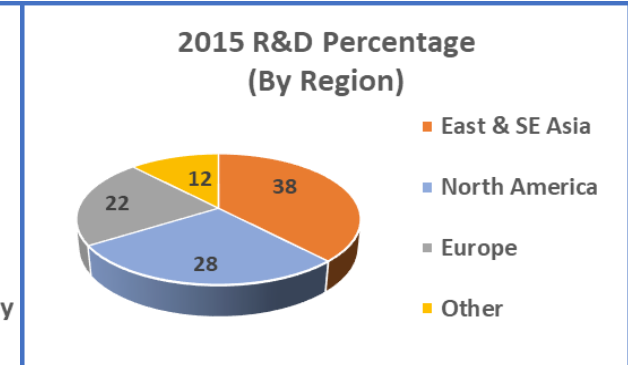
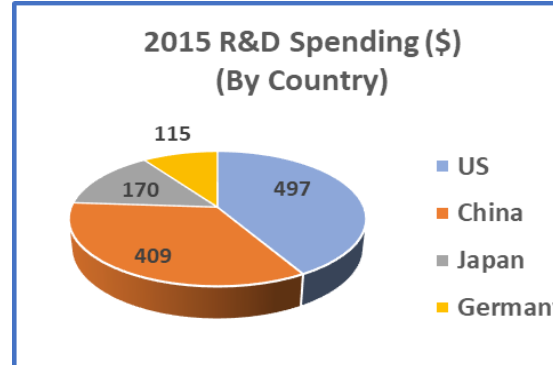
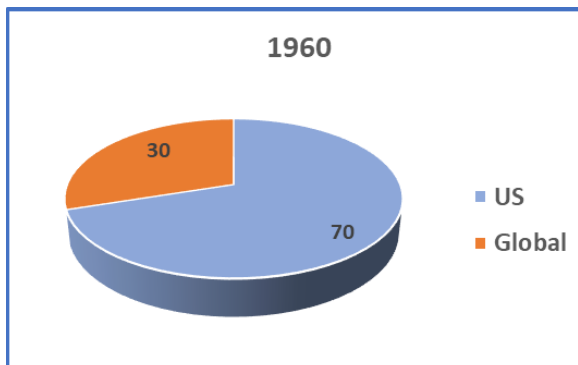
## History

- The “modern” concept of R&D began in the World War II period
- Can be traced back to President Roosevelt’s Science Advisor, Vannevar Bush
- *Science, The Endless Frontier* relates S&T with economic prosperity and national security

## National R&D Trends



## International R&D Trends



# Trend #3 – An Emerging Tech War is on the Horizon

- ❑ Two near-peer competitors with an emerging China and recalcitrant Russia
  - Russia Is a Rogue, Not a Peer; China Is a Peer, Not a Rogue (RAND Report, October 2018)
  - Technology is an integral part of the competition
- ❑ The competitive spaces ...

China	Russia
<ul style="list-style-type: none"><li>– Determined to gain global dominance and leadership</li><li>– East China Sea—changing facts on the ground</li><li>– Belt and Road Initiative (BRI)</li><li>– Made in China 2025 (lead in 10 key military and civilian technologies)</li><li>– Great Firewall of China</li></ul>	<ul style="list-style-type: none"><li>– Restore near abroad</li><li>– Challenge in key areas (Ukraine, Baltics)</li><li>– Challenge in military technologies (air defense, hypersonics, nuclear weapons, cyber)</li><li>– Putin is an opportunistic risk taker (with examples in Syria, and with Turkey and NATO)</li><li>– Russia’s ‘sovereign’ firewall</li></ul>

“China and Russia want to shape a world consistent with their authoritarian model.”  
(2018 National Defense Strategy)

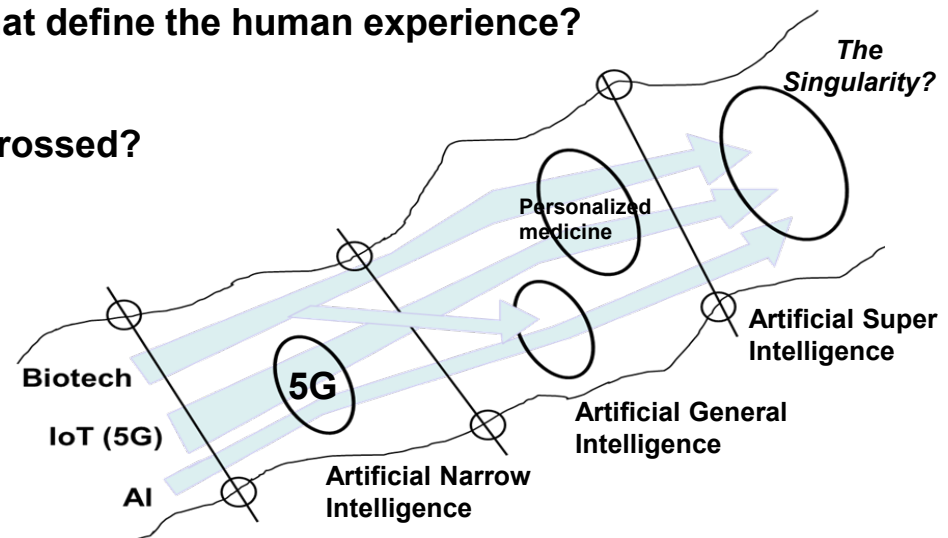
# ***Trend #4 -- Evolving Expectations for Society ... Privacy, Liberty, Freedom***

- ❑ **Someone will always be watching, listening and collecting**
  - Can privacy, liberty and freedom survive in this growing technologically convergent world?
  - Can one go off the grid and stay off the grid?
- ❑ **What the American Civil Liberty Union (ACLU) says ...**
  - **Internet Privacy**: With more and more of our lives moving online, intrusions by governments and corporations have devastating implications for our right to privacy
  - **Location Tracking**: Law enforcement is taking advantage of outdated privacy laws to track Americans to record your every movement, and reveal detailed information about individuals
  - **Privacy at Borders and Checkpoints**: Government developed programs and technologies subject travelers to stops and searches at the border, potentially violating the basic tenets of our Constitution
  - **Medical and Genetic Privacy**: Medical and genetic information can reveal some of the most personal and private data about us. As medical records are increasingly digitized and genetic sequencing becomes faster and cheaper, threats to our privacy and autonomy intensify
  - **Surveillance Technologies**: Companies and government agencies deploy new privacy-invasive technologies before subjects are aware that they exist—and certainly before we have consented to their use
- ❑ **What does that mean for:**
  - Systems with embedded communications
  - Future of screening, security and law enforcement
  - Fused sensors

# Trend #5 – Technology's Increasing Risk to Humanity

- ❑ Few controls on technology development
  - And normally only after harm becomes apparent
  - State-like capabilities in hands of non-state actors
- ❑ What does the future look like at the intersection of AI, IoT and biotech?
  - Why biotech, IoT and AI?
    - AI ... could alter how we see humans in terms of cognition, perception, judgment, creativity
    - IoT ... creates an interconnected world with humans as nodes in the network
    - Biotech ... potential to alter the human germline
  - Ask yourself
    - What are the qualities and attributes that define the human experience?
    - Which of those do we wish to retain?
    - Are there redlines that should not be crossed?

*It is imperative to determine the principles that will be used to guide this development. Will they come from biotech, IoT, AI or some combination?*



# ***Implication -- Managing Tech Development Has Become More Challenging***

- ❑ **Technology development is ...**
  - Done within an increasingly globalized tech development ecosystem
  - Must continue to focus on solving operational problems
- ❑ **Some tools of technology development**
  - Capability development process (JCIDS and DOTMLPF-P)
  - Horizon scanning and Technology forecasting
  - Technology Readiness Levels (TRL)
  - Technology Assessment Methodology (TAM)<sup>1</sup>
  - Portfolio management
- ❑ **Government (including DHS and DoD) must become better consumers**
  - Greater need for collaboration
  - Can no longer dictate all the terms
  - Must growth technical expertise in many key areas
  - Social responsibility increasingly important in industry
  - Novel procurement approaches to develop capabilities more rapidly have emerged
    - Finding ways to get around the Federal Acquisition Regulation (FAR)
    - Venture capitalists such as In-Q-Tel
    - Middle Tier Acquisition (Section 804)—rapid prototyping and fielding
    - Other Transactional Authorities (OTA), Defense Innovation Unit (DIU), Strategic Capabilities Office (SCO)



# ***Implication -- Controlling Technology Has Become Considerably More Challenging***

## **❑ Concerns**

- Can we (and should we) limit the advance of technology?
- Could “controlling” technology negatively affect US industry?
- Are we outpacing policymakers ability to place controls on technologies?

## **❑ Do current methods for managing technology work in digital age?**

- Arms control (i.e., international laws)
- International nonproliferation regimes
- Foreign Military Sales
- Export controls
- National laws
- Patents and Intellectual Property Rights
- Policies
- Regulations
- Standards
- Norms & ethics

## **❑ Must consider both the use and misuse cases ...**

- Simultaneously
- Early in a technology’s lifecycle

## **❑ Balancing technological advancement with safety and security of society requires a technology risk management framework (RMF)**

- Measures will likely vary for different technologies
- Must identify the point in a technology’s lifecycle when dual use concerns are likely to arise
- Must avoid technological surprise

# *Implication -- Growing “Competition” between Humans and Computers*

- ❑ **“Direct competition” between humans and AI systems is on the near horizon**
  - **Some might say already here**
    - What are the qualities and attributes that we define the human experience?
    - Which of those do we wish to retain?
  - **How should we think about?**
    - Artificial Narrow Intelligence (ANI)
    - Artificial General Intelligence (AGI)
    - Artificial Super Intelligence (ASI)
  - **What about?**
    - Future of Work?
    - Future of screening and law enforcement?
    - Future of Warfare?
- ❑ **As we think about the future of AI, perhaps certain tasks**
  - **Predominantly human: tasks requiring creativity, compassion, judgment reserved for humans**
  - **Mostly AI: others become largely the domain of AI systems: optimization, repetitive actions, precision (and calculations)**
  - **Shared: human-machine teaming**
- ❑ **Cannot lose control of the algorithm!**
  - **Data protection and completeness**
  - **Understanding how algorithm works ... and its limits**
  - **Magnifies importance of testing through validation and verification**

# ***Implication – Going Faster Has Important Benefits***

## **□ Democratization of technology means ...**

- Changing balances of power**
- Lessening time between new generations of technology (e.g., information technologies)**
- Shrinking gaps for US assured superiority**
  - “All of China’s fighters in 2000, with the potential exception of a few modified Su-27s, were limited to within-visual-range missiles. China over the last 15 years also has acquired a number of sophisticated short and medium-range air-to-air missiles; precision-guided munitions including all-weather, satellite-guided bombs, anti-radiation missiles, and laser-guided bombs; and long-range, advanced air-launched land-attack cruise missiles and anti-ship cruise missiles.” (Defense News, 2014)**
  - “Over the past two decades, China's People's Liberation Army has transformed itself from a large but antiquated force into a capable, modern military. Although China continues to lag the United States in terms of aggregate military hardware and operational skills, it has improved its relative capabilities in many critical areas.” (RAND, 2015)**
  - “Competitors like Russia and China are closing the advanced weapons gap with the United States, aiming to push the U.S. out of areas on their front doorstep.” (The Hill, 2016)**

## **□ To respond, we need to ...**

- Conduct purposeful R&D that results in acquisition programs**
- Look for asymmetric offsets either at the system or capability level**
- Look for new procurement vehicles ... improve access to technologies**
- Look for opportunities to protect key technologies and IP ... and go faster**
- Limit periods of vulnerability ... outpace competitors countermeasures capabilities**

# *Implication – Assess and Mitigate Vulnerabilities*

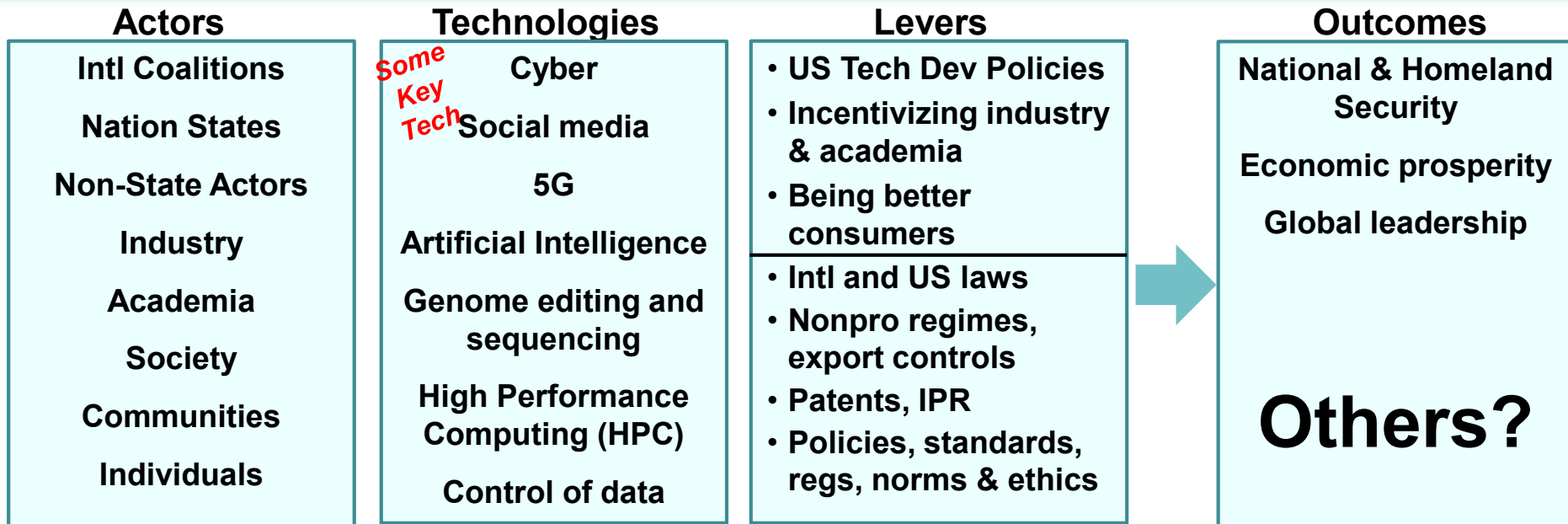
- ❑ **Avoid strategic surprise in new technologies (e.g., quantum, AI, biotech, materials)**
  - Consider the system or technology within the operational context
- ❑ **Look for offsets to vulnerabilities**
  - Establish network of strategic scouts
  - Question assumptions periodically
  - Understand how systems might be (inadvertently) touching the network
- ❑ **Reduce vulnerability of supply chains**
  - Must look deep into supply chains at 1st, 2nd, 3rd tier suppliers
  - Protecting intellectual property (IP)
- ❑ **Requires ...**
  - Assessing and mitigating to be a continuous process
  - Conducting “red teaming” and risk-based analysis to examine potential vulnerabilities

# Understanding Changes in Technology: Technology Assessment Methodology (TAM)

*Methodology examines availability of a technology ....*

	<b>Science &amp; Technology</b>	<b>Use Case, Demand &amp; Market</b>	<b>Policy, legal, ethical &amp; regulatory</b>	<b>Resources</b>	<b>Accessibility</b>
<b>Assessment</b>	What is the level of maturity of the science and technology under consideration?	Is the technology likely to be an essential component or building block for advancement in biotechnology or other fields?	Are policy, legal, ethical or regulatory barriers likely to serve as a barrier to the development of the technology?	Are resource expenditures promoting development of the technology?	Are controls on the technologies likely to limit access to the wider population or be too technically sophisticated for general use?
<b>Rating</b>	<ol style="list-style-type: none"> <li>1. Theoretical and proof-of-concept</li> <li>2. Initial use cases</li> <li>3. Significant limitations</li> <li>4. Modest limitations</li> <li>5. Few/no limitations</li> </ol>	<ol style="list-style-type: none"> <li>1. Innovator use only</li> <li>2. Early adopter use</li> <li>3. Specialized uses only</li> <li>4. Majority users</li> <li>5. Broad use in variety of applications</li> </ol>	<ol style="list-style-type: none"> <li>1. Absolute barriers to entry (BOE)</li> <li>2. Significant BOE</li> <li>3. Some BOE</li> <li>4. Few BOE</li> <li>5. No BOE</li> </ol>	<ol style="list-style-type: none"> <li>1. Little/no investment</li> <li>2. Declining investment</li> <li>3. Steady investment</li> <li>4. Increasing investment</li> <li>5. Exponential investment</li> </ol>	<ol style="list-style-type: none"> <li>1. Extreme limits</li> <li>2. Significant limits</li> <li>3. Some limits</li> <li>4. Few limits</li> <li>5. No limits</li> </ol>
<b>Assessment Areas</b>	TRL/KRL/MRL	Number of people/groups using	Legal/policy/ethical barriers (includes public perceptions)	Indirect investment (R&D, personnel, lab space)	Cost to Use
	Publications	Need/potential impact	Technical leadership	Tech development cost (direct costs)	Regulatory
	Patents	Innovation/perceived investment risk	Export Controls	Total research dollars (denominator)	Technical
	Miniaturization	Business case	Existing regulations/ Ability to regulate	Organization of investment	Who has access to tech?
	Life cycle improvements	Number and size of compan(ies) that own IP or doing the R&D	Comparative advantage	Grants (government, philanthropic funding, etc.)	Democratization/deskilling

# What are the skirmish lines in our increasingly technology-enabled world?

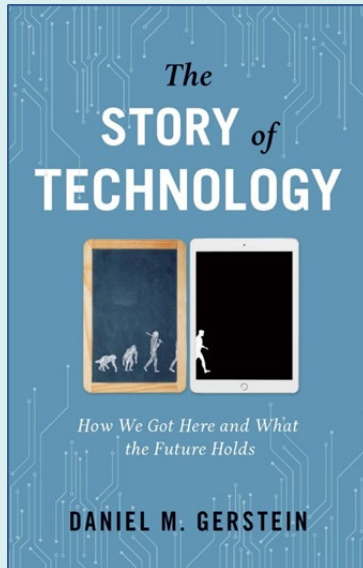


- **5G:** Hinderances to US competitiveness include spectrum decisions and security concerns about Chinese hardware – will have vital impact on economic competitiveness
- **Social media and deep fakes:** Has become a free-fire zone – election hacking and fake news
- **Immigration:** Immigrant Nobel Prize Winners Since 2000 are 33 of 85 (39%)
- **Big Data Catch-22:** Need to consolidate vast amounts of data, but that creates vulnerabilities
- **Cyber:** Another free-fire zone ... companies either know they have been hacked, or have been hacked and don't know it ... most insecurities occur at the application layer ... potential for physical destruction
- **Export controls:** Changes likely needed given growing digital based economy
- **AI:** Goals for AI use are “responsible, equitable, traceable, reliable and governable” (DoD DIB 10/31/19)

*Some Tech Challenges*

# ***The Story of Technology***

## ***How We Got Here and What the Future Holds***



Prometheus Books  
October 2019

<https://rowman.com/ISBN/9781633885790/The-Story-of-Technology-How-We-Got-Here-and-What-the-Future-Holds>

**What is technology and where does it come from?**

**Can technology be managed?**

**What is the appropriate balance between discovery and prudence?**

**What does the history of technology tell us about the future?**

**How can we shape a future that is hospitable – or at least not threatening – to humanity?**

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