

## Global Trend Brief

# Accelerating Pace of Change in Science and Technology

*ASTC's Global Trend briefs—as part of our Global Trends Framework, developed by the ASTC Global Trends Committee—offer a summary of a significant societal, economic, civic, scientific/technological, or other trends that are currently impacting the work of science and technology centers, museums, and other science engagement organizations. This briefing summarizes key data and research about the trend and provides examples of promising ways that organizations within our field and across sectors are responding. Access the Framework and other briefs here: <http://bit.ly/3Re2E6E>*

For many scientific and technological pursuits, progress is exponential, increasing in speed over time. Rapid advances in science and technology can be observed across sectors, including artificial intelligence and automation, health technologies, and agricultural and food science. These advances have important implications for science centers and museums, beyond the impacts that changing technologies have on every business, as the accelerating pace of these new discoveries makes it more difficult to keep the content of programs and exhibits relevant over time. New technologies are continuously being incorporated into daily life, and individuals need to be armed with an ever-increasing body of knowledge to make informed decisions about everything from what they eat to what digital tools they use at work. Additionally, many museums can themselves contribute to scientific and technological advances and bring their audiences along in doing so.

## Research Summary

### Exponential Growth

Moore's law—perhaps the most famous example of the accelerating pace of change in technology—was coined in 1965 and accurately predicted the exponential increase of the number of transistors in integrated circuits. Today, there is a growing recognition that Moore's law cannot be sustained indefinitely due to physical limitations<sup>1</sup>, but the general assertion that technology grows exponentially has become a common aphorism and central assumption informing what we expect from the future. Not every technology is as easily quantifiable as the number of transistors in a circuit, but reasonable arguments can be made that we are seeing exponential growth in technologies from the smartphones in our pockets to the genome sequencers in the most advanced laboratories<sup>2</sup>. As each technological advance provides new tools to build upon, we can expect to see rapidly increasing innovation in a wide range of fields. In fact, according to some futurists such as Ray Kurzweil, observations of technological change reveal double exponential growth, in which the rate of exponential change is itself growing exponentially<sup>3</sup>.

This rapid technological growth is not simply a theoretical curiosity or even a future concern but is influencing people's lives today. Rapid technological change does not happen in a vacuum but interacts with other social forces and ethical questions. New technologies often reinforce existing inequalities, as larger businesses and richer countries are able to invest more in research, attract more skilled workers, and reap the first rewards from the new technologies they produce<sup>4</sup>. Even on an individual level, technological progress tends to disproportionately benefit high-skilled workers over low-skilled ones. It is estimated that 400 million jobs will be displaced by automation by 2030, resulting in an average of one-third of the workers in industrial countries needing to change their occupational category<sup>5</sup>. This has profound implications for not only how current generations live and work, but also how we educate future generations<sup>6</sup>.

## **Artificial Intelligence and Automation**

"Artificial Intelligence" (AI) is a general term that refers to computer systems that can perform humanlike tasks such as visual perception, learning, and problem-solving, as well as the study of those systems. In recent years, AI has become a common topic of discussion for the general public. DALL-E, a deep learning module that generates digital images, was released in January 2021, while ChatGPT, an AI chatbot, was released in November 2022. GPT-4 was released in early 2023 with big leaps in memory and summarization performance<sup>7</sup>. Although "Artificial Intelligence" has become the popular term for these new technologies, many experts decry the use of "AI" to describe things like ChatGPT. ChatGPT is a Large Language Model (LLM) that essentially operates as a more advanced form of autocorrect, and only gained simple reasoning skills incidentally to its language learning. This technology is a far cry from the sort of general AI that appears in science fiction, the kind with general intelligence equal to or exceeding that of humans<sup>8</sup>. All the same, these new technologies are still having a profound impact on daily life. AI is no longer a research interest limited within the field of computer science, and it is having a real impact on many other fields. For example, AI systems can already assist with the diagnosis of rare diseases<sup>9</sup>, help monitor and manage the health of crops<sup>10</sup>, and improve safety in transportation<sup>11</sup>.

While AI has profound implications on many aspects of our lives, in many ways, it represents the next step in the historical process of increasing automation that brought us mechanized looms and computers. Many of the concerns currently expressed about how AI may impact the workforce are similar to those raised during the Industrial Revolution, but with the major difference that AI is poised to affect higher-paying, professional jobs that have previously been perceived as immune to the impacts of automation<sup>12</sup>. Beyond the concerns about workforce impact, there are deeper ethical and safety questions around AI. Geoffrey Hinton, a pioneer of neural networks, recently stepped down from Google citing concerns that generative intelligence like ChatGPT may ultimately present unconscionable risks.

## **Health Innovation**

Recent years have seen many significant leaps in biomedical research and medical technology, one of the most widely recognized examples is the application of mRNA technology to rapidly develop vaccines against COVID-19. Research into mRNA vaccines began in the 1990s, but the COVID-19 vaccines were the first mRNA vaccines to be approved in the United States<sup>13</sup>. This is an excellent example of how a relatively obscure technology can become globally relevant, seemingly overnight.

Some of the top medical innovations in 2022, as chosen by the Cleveland Clinic, include novel treatments for common medical conditions like high cholesterol, type 2 diabetes, and postpartum depression<sup>14</sup>. Moreover, groundbreaking biomedical research, such as that conducted as a part of the BRAIN Initiative is revolutionizing our understanding of the human brain and is leading to significant social and ethical questions, as well as treatments for a range of neurological and psychological disorders. Human genome editing (HGE) has also recently become an option for treating some diseases, such as sickle cell disease and leukemia. Like any new technology, many of these biomedical advancements have significant ethical questions attached to them. For example, the use of HGE raises questions including whether it is appropriate to use these techniques on babies, whether heritable germline edits are acceptable, and the issue of inequitable access to these therapies<sup>15</sup>.

## **Future of Food**

It is estimated that the world's population will reach 10 billion people by 2050, which will necessitate a 60% increase in food production<sup>16</sup>. Existing and emerging technologies are capable of addressing all of the four dimensions of food security: food availability, access, use, and stability. New methods of collecting and analyzing big data have increased agricultural efficiency. For example, the Third Eye project in Mozambique used drones to help farmers improve crop production by 41%<sup>4</sup>. However, these improvements to existing agricultural practices will likely not be sufficient to sustainably feed a growing population, as a 50% increase in food production with current technologies would result in an 80% increase in greenhouse gas emissions. Therefore, even more disruptive food technologies, such as the production of microbial protein as a food source, are likely to expand in the coming years<sup>16</sup>. Some of these innovative foods may become new examples of technologies with long research histories that rapidly gain public attention, and the public will be looking for reliable information to inform their decisions about incorporating these new foods into their lives.

## **Implications for the Science Engagement Field**

The accelerating pace of change presents a significant challenge for science centers and museums that are working to provide up-to-date information about science and technology; supporting their audiences in preparing for a rapidly changing future; and presenting a compelling user experience for accessing this information.

### **Cutting-Edge Content**

While some museums focus largely or exclusively on historical content, many others aspire to offer information about the latest advances in science and technology. This presents a problem for exhibits that may be up for many years, as eventually their content is no longer accurate and up to date. Moreover, the increasing pace of new discoveries can mean that information is out-of-date before a new exhibit is even finished being built.

### **Future Literacy**

If one goal of museums is to provide useful information to audiences, one aspect of this would be preparing audiences to deal with the accelerating pace of change itself. This may include things like informed predictions about expected scientific advances or highlighting

areas of basic science and early-stage research so the public is better able to understand the advancements that come out of this research. Finally, focusing on core principles such as critical thinking skills and a knowledge of scientific methods may help the public better evaluate the validity of sources and understand rapid developments as they occur.

## **User Experience**

Advances in technology have rapidly expanded individuals' ability to access information on their own terms, from the creation of the internet to Wikipedia, to ChatGPT, and beyond. Changes in the way that the public consumes information will continue to impact the unique value museums provide as places of learning and engagement. The wide proliferation of advanced visual, auditory, and experiential technology will mean that there will be consumer pressure on museums and science centers to use technology and engagement approaches that feel fresh and current.

## **Guiding Questions**

To best make use of this Framework and the accompanying Trend Briefs, ASTC encourages our members to ask themselves and their colleagues questions about their expectations for the future and the ways in which they plan to address these changes. While we can offer research about broad trends and responses, only you have specific knowledge of how these trends show up in your community, and how your institution is poised to respond to them.

- Historically, has your museum featured more “cutting-edge” science, or more “basic” science?
  - Is this balance working well, or should it change?
- What is the most recent scientific or technological discovery that you feature at your museum?
  - Is the program or exhibit up to date?
  - Are staff and/or volunteers educated about new information on these topics?
- What new technologies do you (and/or your coworkers) use at work?
  - Are there any that interest you, but that you haven't tried yet?
- Do you have partnerships with active research organizations, such as universities or companies doing research on technology, healthcare, or agriculture?
  - Do you feature any of their work in your museum?
- Do you have partnerships with any larger museums? Can they support you in creating more exhibits or programs on recent research?
- Are your exhibits and/or programs flexible and easily updated? If not, how could they be made quicker and more cost-effective to update?

## Relevant Examples

To access digital versions of this document with clickable links, visit <http://bit.ly/3Re2E6E>

### **The Misalignment Museum** (San Francisco, California, United States)

This temporary pop-up ran until May 2023 in San Francisco, and there are plans to create a permanent museum. Their collection of thought-provoking art pieces, often made in collaboration between AI and human artists, invites visitors to reflect on the possibilities – positive and negative – of AI.

### **Seoul Robot & AI Museum** (Seoul, South Korea)

The unique building that will hold this museum is being built almost entirely by robots, making its construction the “first exhibition”.

### **AI: Mind the Gap at the MIT Museum** (Cambridge, Massachusetts, United States)

This ongoing exhibition allows visitors to learn about AI while directly interacting with it through activities like collaborative poetry writing and drawing emotional expressions for the AI to categorize.

### **Future Food at the Deutsches Hygiene-Museum** (Dresden, Germany)

This exhibition walks visitors through the production, transportation, and consumption of various foodstuffs in the past, present, and multiple possible futures.

### **Cut + Paste at The Francis Crick Institute** (London, England)

This exhibit is the UK’s first exhibition dedicated to exploring public attitudes toward genome editing. Visitors are encouraged to share their thoughts about the ethics of human genome editing through a series of hands-on activities.

## Further Reading

- [Accelerating technological change and hyperconnectivity](#) (European Commission) – The European Union labels this as a “megatrend” and discusses smaller trends within it, through the lens of their political and social implications.
- [The Importance of AI Policies: Laying the Foundation for the AI Revolution](#) (Forbes) – Generative AI can be beneficial, but its use also presents risks. Leadership must make decisions around AI, such as when to disclose the use of AI to consumers, who owns the rights to AI-generated content, and how employees will be trained to work with AI.
- [Best AI Grant Writing Tools](#) (Grantboost) – While ChatGPT has become a relatively popular tool for grant writers to improve their efficiency, it has some drawbacks. Grantboost’s AI Tool was created to help with a range of instruction prompts, templates, and examples to help save time and effort on writing grant proposals.
- [9 Ways ChatGPT Can Empower Museums & Cultural Organizations in the Digital Age](#) (Cuseum) – This article describes some of the many ways in which ChatGPT could be used at a museum, from marketing to translation to analyzing visitor data.
- [Top 10 Medical Innovations for 2022 Unveiled](#) (Cleveland Clinic) – Each year, the hospital identifies the top 10 medical technologies that are expected to have a significant clinical impact and a high probability of being widely adopted within the next year.

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