1. *Prioritization*

TIP should prioritize how innovations in technology can serve as tools to advance public interest, not just approach tech as a solution or as an end in itself. Embedding a public interest technology framework into the digital ecosystem requires a multistakeholder approach that includes legal and regulatory frameworks, clear governance structures, human-centric by-design approaches to technology development and management, a robust civil society, and engagement with local communities. Every community is grappling with balancing the potential of innovation opportunities with the risks of digital technologies. But too often, one harmful innovation is replaced by another harmful innovation.

A public interest technology framework that acknowledges digital harms and seeks to create a safer and more trustworthy future is essential in finding alignment and facilitating cross-sector collaboration. To advance U.S. competitiveness in identified key technology focus areas and to address societal, national, and geostrategic challenges associated with these technologies, New America's Public Interest Technology University Network (PIT-UN) recommends that TIP prioritize two investment areas: key research and workforce development.

A. Key research

Advancing a public interest tech framework (a commitment to privacy, safety, security, sustainability, equity, and ethical behavior) through sustainably funded research efforts can test assumptions and anticipate potential opportunities and challenges in charting a new course. We propose six areas for investigation:

- How can we better govern rapidly evolving technologies to ensure that they serve the public interest without stifling the pace of innovation?
- How can a broader coalition of cross-sector expertise and perspectives be incorporated into all stages of technology development — including designing, testing, implementing, and managing existing and emerging technologies?
- How can trained technologists be encouraged and incentivized to consider career opportunities in the public and civil society sectors?
- How can academic interventions bridge the gap in understanding the ethical and societal implications of technology between future engineers and designers with future legal and policy experts?
- How can we ensure that community members can build calibrated trust in emerging technologies, where public trust aligns with the technology's trustworthiness?
- How can advances in technology be leveraged to serve the public good and provide solutions to inequitable access to education, opportunity, or other services?

B. Workforce development

We recommend that TIP, complementary to other NSF Directorates, prioritize funding opportunities that catalyze culture change in support of public interest technology (PIT) and

workforce development. This involves training a workforce that can develop and use a public interest tech framework and can expand expertise in government, academia, and civil society, as well as the private sector.

- In the immediate term, TIP can prioritize supporting PIT fellowships for graduate students and postdocs working to advance cross-sector collaboration and research on how to operationalize a PIT framework at the product development, data management, and institutional levels. Critical use–inspired models of governance and translational research should be driven by an interdisciplinary approach to developing technology in the public interest.

- In the medium term, TIP can support the development of programming, research, and system implementation at academic institutions to help train a PIT workforce, with a particular emphasis on ensuring that governments and nonprofits are staffed to leverage technology to serve the public interest. Universities are among the largest users, procurers, and developers of technology in the country. They play a critical role in training the high-tech workforce and can serve as laboratories for experimentation and innovation.

2. *Suitability*

TIP should anticipate the implications of emerging technologies on individuals and communities, specifically who is using the technology and for what current or future use. With this knowledge, governments and communities can better intervene to maximize opportunities and minimize costs for Americans, ensuring that these technologies can serve as trusted tools to support a more sustainable, just, and equitable society.

Specifically, we view the most critical technologies as artificial intelligence (AI) and extended reality (XR). For both of these sets of technologies, we need to focus on such areas as data privacy; human rights such as freedom of association and speech; cybersecurity; and safety.

Due to their potential impact on society, these emerging technologies require guardrails and sufficient expertise in the public sector to develop policy, legislation, regulation, and community standards. Technologies or topics that are well suited to use-inspired and translational research, especially as it supports the development of related and applied soft skills, should center on AI, XR, and emerging technologies. Artificial intelligence and natural language processing can be used to measure indicators of diversity; machine learning can be used to model optimal team formation; and distributed ledger technology can be used to monitor team progress and innovation.

To truly prioritize diversity into the tech talent pipeline, there must be significant investment in paid fellowship and apprenticeship programs. These skills programs should be aimed at developing important capacities in the general workforce and encouraging the necessary parallel efforts in higher education to prepare all students for the workforce of the future. These programs must focus heavily on how to leverage open-source technologies and open data. Specific efforts should be made to ensure that a two-year apprenticeship model will provide students with a strong liberal arts and sciences foundation alongside the application of learned skills into PIT-related projects. The skills

learned through these programs could serve better human-centered outcomes in both the private and public sectors.

3. *Workforce*

The implementation of innovations and the discovery of novel or new applications of digital solutions are advancing at an unprecedented rate. It is imperative to address these changes now at the foundational level of a public interest technology workforce. A PIT-focused workforce starts with a PIT-focused education in higher ed and is supported by a PIT-savvy community of practice. These are the prerequisites to a thriving digital ecosystem that is technologically innovative, equitable, and just.

The technology workforce must represent the public and be inclusive of race, ethnicity, gender identity and expression, sexual orientation, age, ability, and geography at all levels of industry. This workforce must have access to the education and training opportunities necessary for entry-level roles through senior management and C-suite roles. Fundamental to the development of a PIT workforce and a socially responsible society is the integration of PIT training within higher ed. Two essential components to this foundational education are entrepreneurship and innovation.

TIP has the opportunity to advance and steer the development and production of the appropriate workforce ready to meet both short- and long-term challenges and to leverage the opportunities presented by advancements in technology and innovation. PIT-UN institutions and others are exploring a variety of curricula and programmatic models to help students develop tech literacy, with particular emphasis on the social impacts of tech, a sense of what social controls can be used to better implement and manage tech — law, policy, best practices, standards, and the like — and pragmatic strategies to promote privacy, security, safety, equity, ethical behavior, and other public interests in tech-enhanced environments.

Better alignment of the foundational capabilities of the tech workforce is important to the governance of all digital solutions. Advances in AI and XR will likely require the greatest workforce needs in the next one to five years. While workforce development programs often focus on meeting the needs of industry, TIP can play an essential and powerful role by making sure that our nation's technology workforce also better serves the public interest.

To date, a commitment to diversity has not been reflected in the technology workforce. This omission has exacerbated the potential for increased economic gaps and potential harms for people and communities not represented in the workforce.[1,2,3] A first priority for workforce development must be to increase the capacity of a truly representative workforce trained in public interest technology. This is a necessary condition for the tech industry to understand and center the communities the workforce represents, such that industry can imagine, design, build, and deploy technologies that are responsive to the public. The goal must be to fortify a trained technology workforce that can help

[1] Howard, A., & Isbell, C. (2020). Diversity in AI: The invisible men and women. *MIT Sloan Management Review*, *62*(2).
[2] McIlwain, C. D. (2019). *Black software: The internet and racial justice, from the AfroNet to Black Lives Matter*. Oxford University Press.
[3] Crowell, R. (2023). Why AI's diversity crisis matters, and how to tackle it. *Nature*.

ensure that the private and public sectors develop technology infrastructures, products, and services that improve lives and serve the needs of all members of society, including historically marginalized and vulnerable populations, and that they mitigate potential harms and advance economic opportunities.

Second, training a workforce needs to include thoughtful preparation for technologists to serve or understand workforce dynamics in all areas of the industrial economy and the technology ecosystem in both government and civil society. Significantly developing capacity in these two sectors will ensure that communities represented in the workforce also have the power to participate in digital solution governance, especially in AI, from the standpoint of prioritizing and incentivizing the development of products and services that serve the public interest as well as regulating and helping to hold industry accountable.[4,5]

Third, building and sustaining a technology workforce prepared to serve the public interest requires training individuals who have the educational background to understand society and ethics combined with the technical training to imagine, design, build, and deploy digital systems, products and services. The technology harms that have plagued members of underserved communities in particular over the past 60 years are the result of technologists and technology decision-makers building and deploying products, especially AI, with little capacity to anticipate and address societal impacts that may result from innovations or applications of technology.[6]

TIP's programs should seek to strengthen a network of higher education institutions that can provide robust sociotechnical, interdisciplinary, public interest–focused education and training; offer aggressive research translation collaborations and programs; and expand education to industry pathways across the private and public sectors. We offer the following three suggestions for how TIP might approach and accomplish this objective.

A. TIP should provide funding and other incentives to expand postdoctoral opportunities that target emerging researchers from underrepresented groups and provide the time (two to three years) for them to participate in large data models or AI-centered translational research activities. These programs and opportunities should be anchored to institutions that possess one or more of three characteristics.

    a. Established postdoctoral fellowship infrastructure. Such infrastructure has the experience and capacity to provide robust opportunities, mentorship, time dedication, and post-fellowship pathways and incentives whose mission is to expand participation of underrepresented scholars in higher education research, teaching, and field building. The *Partnership for Faculty Diversity* could be one such anchor.

[4] Borenstein, J., & Howard, A. (2021). Emerging challenges in AI and the need for AI ethics education. *AI and Ethics*, *1*, 61–65.
[5] Raji, I. D., Smart, A., White, R. N., et al. (2020). Closing the AI accountability gap: Defining an end-to-end framework for internal algorithmic auditing. In *Proceedings of the 2020 conference on fairness, accountability, and transparency,* 33–44.
[6] Slota, S. C., Fleischmann, K. R., Greenberg, S., et al. (2023). Many hands make many fingers to point: Challenges in creating accountable AI. *AI & Society*, *38*, 1287–1299.

b. Current or developing research translation infrastructures in AI. This includes institutions that define research translation to be inclusive of, but not limited to, efforts to commercialize new AI technologies in the private sector, as well as institutions that have the capacity to train, engage, and provide opportunities to postdoctoral researchers and others to engage in a diverse range of activities that include, but are not limited to, translating research into commercial licensing; startup creation; open-source software and hardware; public policy; intervention by advocates in legal cases or social change campaigns; ethical best practices for use specific to different communities based on race, ethnicity, gender, accessibility, or other identity-based differences; and meaningful structures for maintaining accountability, risk mitigation, and harm reduction.

c. Capacity to operate within a public interest framework. Institutions will demonstrate a commitment to, and an infrastructure for, advancing technology, AI research, teaching, and co-curricular opportunities in ways that prioritize public interest outcomes. Minority-serving institutions are perfectly suited to spearhead this priority as they are committed to addressing issues of diversity and equity, inclusion and access, social justice, and community empowerment, and they have diversified leadership that can develop pathways for academic and professional opportunities and ensure economic viability for underserved groups of students and their communities.

PIT-UN could be a conduit to institutions that already actively pursue this work. Scaling opportunities for underrepresented, early-career researchers has important advantages:

- Connects a diverse set of individuals with a set of workforce expertise in ways that can most immediately contribute to pressing challenges.
- Provides pathways for these members of the workforce to learn from, collaborate with, and innovate with cross-sector stakeholders.
- Helps to institutionalize and sustain efforts by connecting them with institutions that have strong track records of pursuing this work. It also will ensure that translational research activities don't get myopically relegated to just churning out patents but will help build a well-rounded workforce that is well situated to contribute to current industry gaps.

B. TIP should institutionalize workforce development strategies by providing opportunities and the connective tissue to empower stronger employment pathways and incentives for a PIT-trained workforce to connect to other centers for research and development supported by NSF and other government agencies more broadly. This includes the current and future National Artificial Intelligence Research Institutes.

C. TIP should provide financial and other resources such as data, relationships, and programs to reinforce potential employment in the private sector, public sector, nonprofit sector, and higher education (especially with institutions that have the capacity to build innovative curricular and co-curricular programs in public interest technology). There is a need for well-educated and well-trained students who are poised in the next five years to enter the public sector and nonprofit workforce, where they can significantly influence industry and encourage pursuing innovation in ways that provide maximum benefit to the public, while expanding positive outcomes and opportunities.

This type of support would help to advance a comprehensive approach to careers in a wide range of PIT-related activities. These include career fairs that bring students and employers together to define new career pathways that match students' education and skills in sociotechnical approaches to technology and AI; opportunities for the private sector to learn more about a PIT framework; and large-scale executive education programs and cross-institutional programs or cross-sector partnerships that develop the technical skills of students at all levels whose education and expertise are based in the social sciences and humanities.

4. *Addressing societal challenges*

A PIT-centered approach is essential to successful deployment of key technologies. This section is divided into two parallel commitments. The first point presents factors that should be considered across advances in key technological areas. The second covers technology areas that should receive investment priority.

A. Consideration of societal, national, and geostrategic challenges is an opportunity to identify human-centered factors that should be taken into account across the key technology focus areas; these factors shift as each stakeholder group is assessed.

   a. Individuals and communities. Key factors to consider include access, benefit, and protections. All Americans should enjoy access to technologies and benefit from technological progress. NSF should insist not only on nondiscrimination, but also that steps to advance these technological areas mitigate harms. Progress in these technological areas should be shared by all Americans in their everyday lives. Attention must be given to honor and enforce the rights and interests of cultural groups when it comes to technologies.

   b. U.S. policymakers. Emphasis should be placed on oversight, regulation, security, privacy, and accountability. When it comes to technological innovation, a concern is that new technologies often outpace legislation and case law, as well as legal education, whether continuing legal education or law school. Leaders of the U.S. legal system, broadly understood, should consider new approaches to regulating technological innovation. Security concerns around the key technological areas are complex and fluid.

   c. Civil society and academia. Often considered a particular strength and advantage of the United States, civil society and academia offer strong collaboration opportunities for the public and private sectors. Civil society can support technological and scientific cooperation and can also ensure a more independent and trusted voice than many working in the public and private sectors who may have conflicting interests. Academia can provide topical expertise in both technical and social issue areas and offer a connection to the communities that their institutions serve both locally and regionally. Academia can also serve as a safe space in which representatives of all relevant stakeholder groups can engage in joint fact-finding, collaborative problem-solving, and consensus-building with professional mediation assistance and can facilitate voluntary problem-solving.

   d. Private sector and technology leaders. Cross-sector collaboration may be a way to improve people-centered outcomes and effective innovation. NSF should endeavor to reach out to

private sector stewards and invite them into conversations. For example, public-private collaborations are frequently employed when it comes to developing technologies. These hybrid solutions are often fragile and fraught with such challenges as sustainability and incompatible timelines, and they need the support of cross-sector stewardship. When it comes to technology development, a siloed approach is too often the norm. NSF could prioritize more inclusive collaboration opportunities that span the interests of individuals, communities, the public sector, the private sector, and civil society. TIP can significantly enable the private sector to accomplish what it has not been capable of doing on its own, especially with respect to encouraging workforce diversity and promoting responsible development and use of technology. TIP can also foster collaboration with the private sector to align its profit-making objectives to public interest values.

e. Geostrategic alliances**.** Attention should be paid to all aspects of U.S. relationships with other governments and their people; international and regional governing organizations such as the UN, OECD, WTO, ITU, and ASEAN; and nonstate actors. While the "American model" typically refers to the U.S. approach to work and productivity, many nations and their people look to the United States for models of governance, emergency response, innovation and ideas, civil society, and efforts to reduce inequalities and bolster freedoms. NSF already supports U.S. leadership when it comes to providing information and insights into technology and science.

B. NSF should continue to invest in supercomputing while broadening its investments in human-centered, use-inspired, and translational research that apply to other technological areas and scientific endeavors. Innovations in supercomputing may bolster U.S. national security, such as ensuring that the human element remains central. As the United States advances its leadership in supercomputers, other technology areas, such as AI/ML/DL, robotics and automation, advanced communications technology, bio- and medical technologies, data storage and management, and energy and sustainability, will benefit. NSF support of new models of regulation, security, and public-private hybrids, as well as civil society relationships, can strengthen innovation outcomes by offering a model of human-centered approach to advancing technology and science. That in turn would solidify NSF's central role as the American model of scientific and technological innovation.

Given factors to consider, NSF support of education and training around existing and emerging technological areas and scientific endeavors will foster access, including to new workforces; ensure that individuals benefit from technological progress; and avoid or reduce technological harms. NSF's education efforts should transcend universities and colleges to better include K-12 education and lay people whose formal education has concluded.

5. *Additions*

We agree that the 10 listed areas in the RFI provide an appropriate scope for TIP for at least the next five years. It is also important for the scope of TIP to be revisited periodically, and TIP should provide mechanisms for stakeholders and researchers to propose new areas of pursuit and collaboration. As with other Directorates, TIP should set up an Advisory Committee that engages both the growing PIT ecosystem and the public and nonprofit sectors as well as the private sector. This Advisory

Committee can provide advice on the impact of policies, programs, and activities in the disciplines and fields encompassed by the Directorate, with a specific focus on workforce development as it relates to diversity, equity, and inclusion.

6. *Crosscutting investments*

TIP could invest in the following three areas that would have crosscutting benefits across all data-intensive technologies, including AI, high-performance computing, robotics, animation, advanced manufacturing, biotechnology, medical technology, genomics, and synthetic biology.[7,8,9,10,11,12]

A. Tools for secure and efficient data-sharing and collaboration. Several technology focus areas require a means of securely and efficiently sharing data and enabling multi stakeholder collaboration to accelerate the pace of innovation and create synergies. Further research is needed into how a whole data-sharing and collaboration ecosystem can be built that balances privacy and security with utility and accessibility. This effort is not limited to the development of particular technical infrastructure to make sharing feasible, such as data repositories and integrated sensors; it also encompasses intangible assets such as common data standards to ensure interoperability; comprehensive best practices for data governance; and privacy and security methodologies, such as differential privacy and secure multiparty computation. Many of these data sets, including biometrics, are particularly sensitive and, thus, require particularly high standards of privacy and cybersecurity.

   Crucially, further research is needed into how synergies and complementarities among the different components of this system can be leveraged to create a true ecosystem. This includes research into how to align incentives and allocate responsibilities between different participants, that is, ecosystem building as community building as well as technology development.

B. Workforce skill-building and civic education on data-intensive technologies. The benefits of all technology focus areas can be fully harnessed only with the help of a broad pool of skilled labor and a well-educated general public. The former is important because several technology focus areas — including but not limited to artificial intelligence, machine learning, and autonomy — are poised to have impacts on many different areas of the U.S. economy.

   Education efforts should focus on fundamental technological competencies, rather than a narrowly defined set of predetermined technologies and skills. Future basic research breakthroughs and practical technological innovations are nearly impossible to predict with any degree of certainty and broader time horizon. Therefore, any effort to handpick priority

[7] Brown, S. (2022). Why it's time for 'data-centric artificial intelligence.' *MIT Sloan Management Review*.
[8] *IEEE Digital Reality* (2022). AI in Virtual Reality.
[9] HPC makes national security possible (Jan. 19, 2022). Los Alamos National Laboratory press release.
[10] ibid.
[11] World Economic Forum. Unlocking value in manufacturing through data sharing.
[12] Bagga, S., Gupta, S., & Sharma, D. K. (2021). Big Data analytics in medical imaging, in Khanna, A., Gupta, D., & Dey, N., eds., *Applications of Big Data in Healthcare: Theory and Practice*. Academic Press..

technologies will necessarily have blind spots, while an approach focused on conceptual understanding, methodologies, and mental models is more flexible and more forward-looking. In particular, all citizens ought to have an understanding of the basic tenets of the scientific method (hypothesis testing, falsifiability, and the like). At a more advanced level, rigorous, general methodologies for assessing the social, political, economic, and ecological impact of technologies should be taught. Academia can play a crucial role in developing these methodologies and in ensuring there is a pipeline of trained professionals for both the public and the private sectors.

This type of education is not just beneficial for economic and productivity reasons; it also facilitates democratic participation and accountability. Identifying potential risks and clashes with societal values associated with novel technologies is a challenging task. New technologies may affect many different areas of life, on different time scales and via different channels, and these may interact with each other in complex and emergent ways. This system of interactions is often too complex even for multidisciplinary or interdisciplinary research teams to understand. Instead, an inclusive and transdisciplinary approach is required that draws on the expertise and experiences of experts from many different disciplines as well as civil society. Examples of such participatory and anticipatory technology governance approaches[13] include public forums called participatory technology assessment, or pTA, which have been used by NASA to engage with the public on issues of planetary defense,[14] and "anticipatory governance," which has been applied to the governance of nanotechnology.[15] While these are promising initiatives, more research is needed into the extent to which they are effective and how they should be designed.

C. Research and best practice sharing regarding translational research. The RFI's definition of "translational research" is commendably broad, focusing on moving "towards results and outcomes that directly benefit people through societal or economic impacts." In practice, translation efforts often default toward commercialization of research insights as products or services, focusing on the economic impacts of ideas and innovations — not because this is the only path to impact but because it is the one that is the most well trodden and well researched. What is needed to complement this is what could be termed "translational research" or "meta-translational research," in other words, research on how best to do translational research. In particular, this research effort should take on two relatively underexplored determinants of technological impact: how translational research can be applied to noncommercial projects and to address social challenges and how all kinds of technology products, services, and projects can be designed and implemented in a manner that avoids negative externalities and aligns the technology with societal values.

Similarly, this research should not be limited to a particular set of predetermined technologies. All technologies have the potential to promote or undermine societal values depending on how

[13] Guston, D. H. (2023). Making the most of the 'ethical and societal considerations' in the CHIPS and Science Act. In *Issues in Science and Technology*.
[14] Farooque, M., & Kessler, J. (2023). How would you defend the planet from asteroids? *Issues in Science and Technology*, *39*(2).
[15] Guston, D. H. (2014). Understanding 'anticipatory governance.' *Social Studies of Science*, *44*(2): 218–242.

they are deployed. The earlier in the technology life cycle these research insights are deployed, the better; otherwise, changes to technology products may be implemented only after harms have already occurred and by then the changes will be comparatively more difficult, time-consuming, and expensive (as in switching distributed ledger technologies from energy-intensive proof-of-work approaches to more environmentally friendly proof-of-stake approaches). As the CHIPS and Science Act notes, "the incorporation of ethical, social, safety, and security considerations into the research design and review process for Federal awards, may help mitigate potential harms before they happen."[16] It also calls for NSF awards supporting "research to assess the potential ethical and societal implications of Foundation-supported research and products or technologies enabled by such research."[17]

7. *Other topics*

PIT-UN recommends that TIP support or develop a collaborative inclusive process that educates and involves a broader cross-section of stakeholders in discussions about digital transformation, especially with the rapid deployment of AI and XR solutions and products.

About the submission

This RFI is submitted on behalf of the Public Interest Technology University Network (PIT-UN), comprising 60 U.S. and four international members, including 70% of the top tech schools in the nation.

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[16] CHIPS and Science Act 2022, Section 10343(a)(2).
[17] CHIPS and Science Act 2022, Section 10343 (d)(1). See also Guston, D. H. (2023). Making the most of the 'ethical and societal considerations' in the CHIPS and Science Act. *Issues in Science and Technology*.