

NSF Convergence Accelerator Workshop Summary Report:
Socioresilient Infrastructure: Precision Materials, Assemblages, and Systems
Massachusetts Institute of Technology
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Introduction and Background

The NSF Convergence Accelerator sponsored an international, cross-sector, and cross-disciplinary workshop which brought together more than 100 leaders from across academia, industry, non-profit community-based organizations, and government entities on the exciting emerging topic of *Socioresilient Infrastructure* (Ortiz and Spero, 2020). The reimagining, reconception, and redesign of infrastructure, the fundamentally entangled physical, digital, and social frameworks and systems that underpin society, hold enormous potential for addressing urgent environmental challenges, global health disparities, economic and social divides. The NSF Convergence Accelerator Workshop organizing team developed the concept of *socioresilient infrastructure* which addresses this imperative by envisioning a future where infrastructure is intentionally designed to empower human communities to cope with, and adapt to stresses and shocks such as social, political, environmental, or economic change. While there is increasing attention to sustainability and environmental issues, the critical integration of emerging infrastructure technologies with humanistic fields, including history, social sciences, including science, technology, and society studies, social justice, diversity, equity, and inclusion, remains fragmented and a significant challenge.

During this workshop, a framework was explored (Figure 1) for the acceleration of use-inspired convergence research in this area of national importance that integrates exciting advances across length scales from *materials* (materials science and engineering, chemistry, and mechanical engineering) to *assemblages* (civil, structural, and environmental engineering, architecture, art and design) to *systems* (engineering systems, computer science and engineering, urban studies and planning including civic design and engagement) with cross-cutting research in material culture, social justice, community and equity-based design, environmental and social life cycle assessment, environmental justice, sociotechnical and sociological analysis (history, social sciences, including science, technology, and society studies). This workshop demonstrated that the merging of ideas, new computational and manufacturing technologies, research methods, across widely disparate disciplines holds great potential for the development of equitable, inclusive, and sustainable research breakthroughs, innovation, and commercialization of *socioresilient infrastructure*.

There were four interconnected thematic areas: Systems, Assemblages, Materials, and Education. Taking a systems level view, the workshop framed the urgency of planetary crises (climate, nature or biodiversity, and pollution and waste) called for design that takes into account the full life-cycle, highlighting the tension often found between the drive for innovation and the need for regulation and policies to ensure equitable and safe ecosystems. Panelists offered new rigorous systemic frameworks for infrastructure design at the intersection of the technical and social involving big data, models, and methods (e.g. urban, global trade, social life cycle assessment) for more equitable and sustainable social outcomes. Approaches included the incorporation of community expertise and lived experience, neighborhood factors and inequalities, social vulnerability and environmental justice concepts, physical vulnerability, and hazard risk exposure. In the theme of materials, discussion centered on a new mode of precision circular materials design, which involves integrating sustainable material sources, design for structural modularization and self-assembly, with mechanisms for end-of-life material

SOCIORESILIENT INFRASTRUCTURE: PRECISION MATERIALS, ASSEMBLAGES, & SYSTEMS

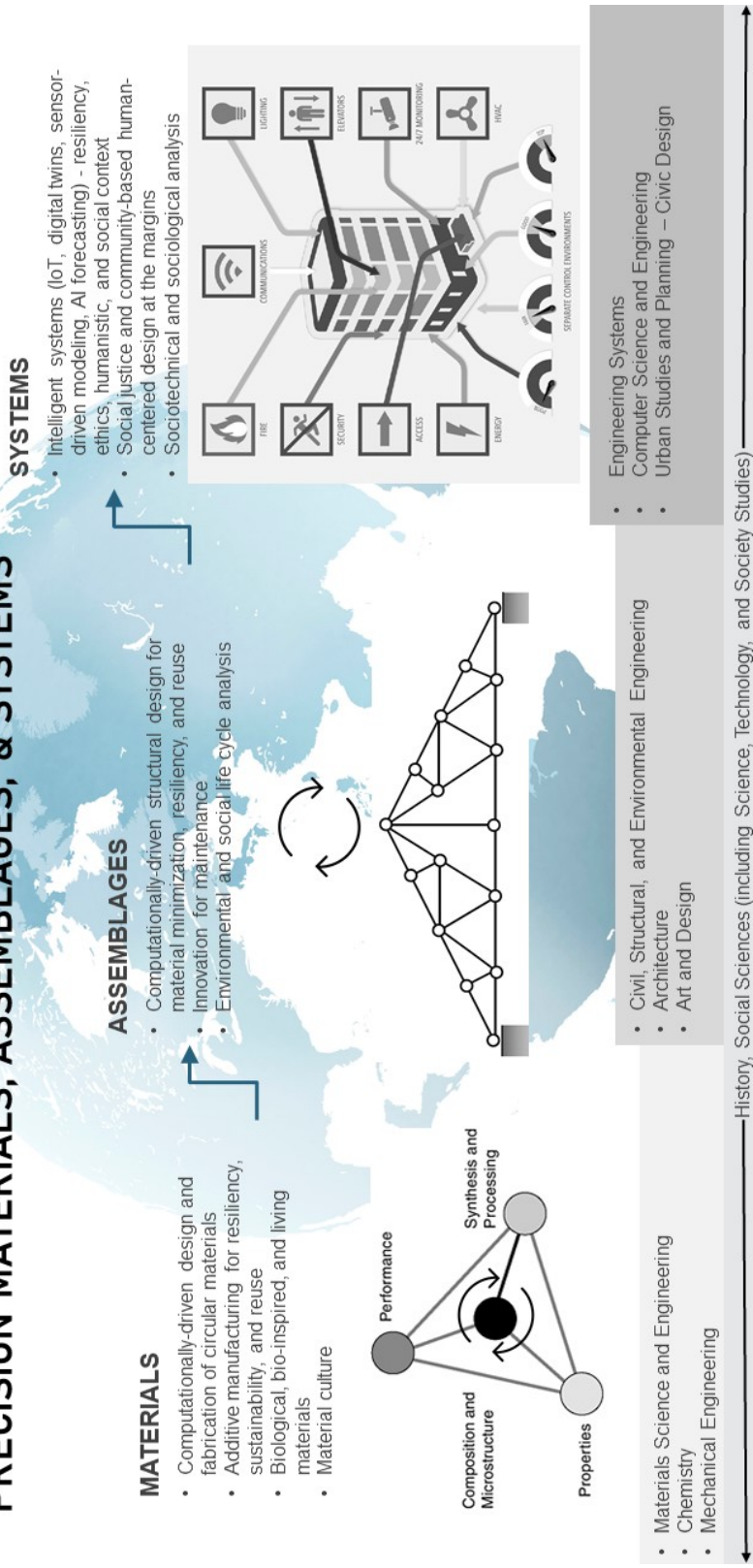


Figure 1. Cross-disciplinary convergence research approach to the development and advancement of *Socioresilient Infrastructure* (systems graphic is adapted from reference (Ortiz and Spero, 2020))

deconstruction and reuse, powered by emerging molecular- to macro- multiscale computational methods such as artificial intelligence and deep learning. Throughout discussions, the power of narrative (that is, the words, numbers, and metrics that both serve to describe our world, fix or overreach boundaries) played a central role in connecting the themes and paths forward across disciplines and sectors. By mobilizing narrative as a research tool, the workshop participants offered strategies to create robust frameworks for materials design choices, frame sustainability with innovation and maintenance, and incorporate social and economic context, and pose questions to imagine more interconnected and robust futures. The fourth session focused on the future of education included systems approaches to advancing education at the intersection of infrastructure, equity, and resiliency, infrastructure for the future of community-engaged and equitable undergraduate education, designing equitable infrastructure for fostering pedagogical social capital, student success, and social mobility in higher education, and infrastructure to advance the science of equitable learning. Each thematic session was followed by a breakout discussion in small groups including one of the featured speakers, facilitator, and workshop participants. The groups were encouraged to take a transformative and visionary approach to future change, each bringing their own expertise to the session topics.