Infrastructure is the foundation that connects the nation’s businesses, communities and people. It drives our economy and improves our quality of life. Advanced Materials for Sustainable Infrastructure has been identified as a signature area of research in which Missouri S&T is positioned to become a top national leader.

CRITICAL TO MODERNIZING INFRASTRUCTURE

The Advanced Materials for Sustainable Infrastructure signature area is critical to improving the nation’s infrastructure in an environmentally sustainable manner.

- **Rebuilding bridges.** The 2013 Report Card of the American Society of Civil Engineers assigned a grade of C+ to American bridges. One in nine of the nation’s bridges are rated as structurally deficient.

- **Investing wisely.** To eliminate the nation’s backlog of deficient bridges by 2028, the U.S. would need to invest $20.5 billion annually.

- **Increasing investments.** To replace or repair deficient bridges, the U.S. must increase investments by $8 billion annually to address a $76 billion shortfall.

- **Improving our economic health.** A robust physical infrastructure is essential as a “building block” of American innovation. An investment in restoring transportation infrastructure is fundamental to economic health.

- **Restoration and advancement.** The Grand Challenges for Engineering report (National Academy of Engineers, 2008) calls for the restoration and improvement of urban infrastructure to advance transportation and energy, water and waste systems as the key to creating more sustainable urban environments.

RE-CONSTRUCTING THE NATION’S INFRASTRUCTURE FOR THE 21ST CENTURY

Missouri S&T’s current leadership and resources address this national dilemma.

- In 2013, S&T was named a Tier-1 University Transportation Center, funded by the U.S. Department of Transportation (U.S.DOT).

- In 2012, S&T was awarded $2.5 million by the U.S.DOT for specialized equipment for construction materials research.

- Plans to construct an Advanced Construction Materials Laboratory will further enhance our capabilities.

EXCEPTIONAL FACULTY AND FACILITIES

Missouri S&T faculty are among the nation’s best, and the university is recruiting new faculty members to build upon a strong foundation in this signature area. The university also has state-of-the-art research equipment for the design and testing of novel construction materials, metal casting, composites manufacturing and materials characterization, as well as six interdisciplinary research centers: the Center for Infrastructure Engineering Studies, RE-CAST University Transportation Center, Materials Research Center, Polymer and Coatings Institute in Chemistry, the Polymer Composite Manufacturing and Testing Laboratory in the Mechanical and Aerospace Engineering Department, and the Peaslee Steel Manufacturing Research Center.
With leading researchers and facilities for additive manufacturing, micro- and nano-manufacturing, and sensor-enabled intelligent manufacturing, Advanced Manufacturing at Missouri S&T is well-positioned to develop into a world-class research enterprise.

CRITICAL TO ECONOMIC DEVELOPMENT

Advanced manufacturing is critical to economic development in Missouri and the nation. Here’s why:

- **Jobs for Missourians.** Twenty-three percent of Missouri’s workers hold jobs in advanced manufacturing-related occupations.
- **Jobs for America.** In 2012, 10 percent of all jobs in the U.S. were in the manufacturing sector.
- **A strong national economy.** U.S. manufacturing accounts for 12 percent of gross domestic product, 70 percent of private R&D spending, and 86 percent of exports.
- **Tremendous return on investment.** Every dollar spent on manufacturing in the U.S. adds another $1.48 to the economy; this is the highest multiplier of any economic sector.
- **High-paying jobs.** In 2011, the average U.S. manufacturing worker earned $77,060 annually, compared to the industry average of $60,168.
- **The key to the future.** Advanced manufacturing ranks No. 1 in the science and technology priorities for the fiscal year 2014 federal budget.

REINVENTING MANUFACTURING — DIGITALLY

Missouri S&T is one of 23 university partners in a national initiative to reinvent manufacturing through Digital Labs. The initiative was announced in February 2014 by President Obama as part of the National Network for Manufacturing Innovation. Relying on the expertise of universities like Missouri S&T, Digital Labs will accelerate innovation and transition of technology to U.S. manufacturing enterprises.

EXCEPTIONAL FACULTY AND FACILITIES

Missouri S&T faculty are among the nation’s best in this emerging field, and with this emphasis on Advanced Manufacturing as a signature area, the university is recruiting new faculty members to build upon a strong foundation. The university also has state-of-the-art research equipment for additive manufacturing, laser processing, metal casting, composites manufacturing and materials characterization, as well as three industrially relevant national research centers: the Center for Aerospace Manufacturing Technologies, Peaslee Steel Manufacturing Research Center, and a site of the NSF Industry-University Cooperative Research Center in Intelligent Maintenance Systems.
ADDRESSING NATIONAL NEEDS

The Enabling Materials for Extreme Environments signature area addresses national needs related to clean energy production, hypersonic flight vehicles and advanced propulsion systems.

- **Solar power.** New materials will make solar energy less expensive by increasing the operating temperature of solar collectors and producing more robust components.

- **Nuclear fusion.** Improved materials can withstand the extreme temperatures, chemical reactivities and radiation of plasma-facing structures.

- **Nuclear fission.** Improved materials increase safety in conventional nuclear power systems.

- **Generation IV nuclear reactors.** Inert matrix fuels and structural components increase reliability.

- **Hypersonic flight.** Sharp leading/trailing edges and control surfaces help enable global reach, reduce time-to-target and increase cross range of weapons systems.

- **Scramjet propulsion.** Reducing weight and increasing operating temperature through ultra-high-temperature ceramics will improve efficiency and simplify designs.

KEY RESEARCH CENTER

Enabling Materials for Extreme Environments includes collaborators in chemistry, materials science and engineering, mechanical and aerospace engineering, nuclear engineering, and physics. This team draws heavily on the resources of Missouri S&T’s Materials Research Center. The MRC is the longest-standing research center on campus and has a history of fostering interdisciplinary collaboration and technology transfer. The MRC provides major research instrumentation including X-ray diffraction, scanning electron microscopy, dual-beam focused ion beam milling and electron imaging, transmission electron microscopy, and X-ray photoelectron spectroscopy.

EXCEPTIONAL FACULTY AND FACILITIES

Signature area leaders have collaborated for over 10 years on ultra-high-temperature structural ceramics for aerospace applications. Their research has amassed a unique collection of highly specialized equipment, including several high-temperature furnaces, a mechanical testing system for measuring strength and elastic modulus up to 2600°C, and a thermal property analysis system capable of operating up to 2800°C. The quality and impact of this research is recognized around the globe. Recruiting additional faculty in this signature area will create long-term growth and widen the impact of the research.
ALL KINDS OF SMART

Smart Living means more than creating intelligent cities, homes and infrastructure. It also means designing systems that people can and will use. Smart Living research areas include:

• **Smart grid and transportation systems.** Intelligent peer-to-peer systems manage renewable energy resources, like wind and solar, backed by energy storage, including fuel cells and batteries, to provide energy to buildings. (Missouri S&T's Solar Village is a "micro" example of a smart grid in operation.) Transportation and energy systems interlink with improved urban planning to provide individualized, cost-efficient transportation.

• **Decision-making and governance.** Smart living requires more than data and analytics. Understanding how people process, react to, and interact with information and technology will lead to a sustainable shared governance of resources.

• **Privacy and security.** Intelligent systems must be resilient to security attacks while maintaining personal privacy and supporting the users' trust in the system. In Smart Living, people must adapt to the technology and the technology must adapt to the people. The result is enhanced trust and security.

• **Building materials.** New smart materials turn buildings into "living laboratories" that, through advanced analytics, provide feedback to inform users as well as to adapt to human behavior. This leads to improved infrastructure, chemical or biological environments, and decision making. Embedded sensors can monitor how efficiently a building uses energy, water or even bandwidth, thereby empowering people to make informed decisions on how to use resources wisely.

FACULTY AND FACILITIES

Missouri S&T's multidisciplinary Smart Living team combines the university's strengths in energy research, architectural design, computing, environmental sustainability and transportation infrastructure with emerging strengths in organizational behavior, design, process improvement, social dynamics, policy, and usability to develop a more secure, sustainable and adaptable society. The Smart Living signature area also involves industry partners and University of Missouri System campuses to make the research a statewide effort.