Institute for Soldier Nanotechnologies

Founded in 2002, the Institute for Soldier Nanotechnologies (ISN) is a US Army University-Affiliated Research Center (UARC) at MIT. The ISN was designed as a three-member team to leverage the unique capabilities of the Army, industry, and MIT. The ISN mission is to help the US Army and other US military services dramatically improve the protection, survivability, and mission capabilities of the Warfighter and of Warfighter-supporting platforms and systems through basic research on nanotechnology and by transitioning promising outcomes of that research in partnership with the Army, other US military services, MIT Lincoln Laboratory, and industrial companies. This mission includes decreasing the weight that Soldiers carry, improving blast and ballistic protection, creating new methods of detecting and detoxifying chemical and biological analytes, providing physiological monitoring and automated medical intervention, and enhancing situational awareness.

Headquarters Team

The ISN features a lean and focused headquarters team of experienced and accomplished professionals in the leadership, administration, and performance of university research, led by a trio of senior executives with more than 100 combined years of MIT experience.

- John D. Joannopoulos, director, Francis Wright Davis Professor of Physics, National Academy of Sciences member, American Academy of Arts and Sciences member
- Raúl A. Radovitzky, associate director, professor, Department of Aeronautics and Astronautics (AeroAstro)
- William A. Peters, PhD, executive director
- Franklin E.W. Hadley, director of outreach and communications
- Joshua Freedman, assistant director for finance and administration
- Ivan Celanovic, PhD, principal research scientist
- Steve Kooi, PhD, principal research scientist
- Amy Tatem-Bannister, manager for laboratory and facilities, Environmental Health and Safety (EHS) coordinator
- Nicole Bohn, specialist for Surface and Electron Microscopy Instrumentation
- Kurt Keville, research specialist
- Donna Johnson, research support associate, EHS representative
- Maureen Caulfield, financial assistant
- Marlisha McDaniels, executive administrative assistant

- John R. McConville, technology transfer officer and Army liaison, Army Research Office, US Army Combat Capabilities Development Command Army Research Laboratory, Department of the Army civilian stationed at the ISN

Research Portfolio

Team-based innovation is a hallmark of the ISN's intellectual course, with new ideas emerging frequently and collaborations with Army researchers a high priority. The ISN's signature interdisciplinary research agenda evolved over the course of its first fifteen years into a focused program reflecting the areas where the ISN and the Army see the potential for exceptionally strong Soldier impacts. For ISN-4, this structure was further updated and redefined to better align with and more efficiently respond to guidance from the Army while working within the constraints of Army budget reductions. The ISN-4 research portfolio was divided into three Strategic Research Areas (SRAs) that were further divided into 16 core 6.1 research projects. However, budget cuts enacted by the Army necessitated the cancellation of two projects—Project 3.2 and Project 3.5—bringing the current count to 14.

Twenty-eight faculty members and research scientists representing a dozen MIT academic departments, labs, and centers, as well as an average of nearly 75 graduate students and postdoctoral associates, participate in ISN research each year. ISN research typically results in close to 100 refereed publications annually, with a large portion of those in prestigious scientific journals such as *Science*, *Nature*, *Advanced Materials*, *Physical Review Letters*, and the *Proceedings of the National Academy of Sciences*.

Strategic Research Area 1: Soldier Protection, Battlefield Care, and Sensing

Project 1.1—Advanced Multiscale Methods for Modeling of Fracture in Novel Nanomaterials
Principal Investigators (PIs): Raúl Radovitzky, AeroAstro; Keith Nelson, Department of Chemistry (Chemistry); and Xuanhe Zhao, Departments of Mechanical Engineering (MechE) and Civil and Environmental Engineering (CEE)

Project 1.2—Shock Mitigating and Reinforcing Molecular Nanocomposites
PI: Michael Strano, Department of Chemical Engineering (ChemE)

Project 1.3—Design & Testing of Polymers for Improved Soldier Protection
PIs: Keith Nelson, Chemistry; Tim Swager, Chemistry; and Greg Rutledge ChemE

Project 1.4—Superelastic Granular Materials for Impact Absorption
PIs: Chris Schuh, Department of Materials Science and Engineering (DMSE); Raúl Radovitzky, AeroAstro; and Kenneth Kamrin, MechE

Project 1.5—Rapid Hemostasis for the Treatment of Incompressible Wounds
PIs: Bradley Olsen, ChemE; and Paula Hammond, ChemE

Project 1.6—Empowering Future Vaccines & Immunotherapies with Nanotech-based Adjuvants
PI: Darrell Irvine, DMSE and Department of Biological Engineering (BE)

Strategic Research Area 2: Augmenting Situational Awareness

Project 2.1—Uncovering Chemical Stability & Charge Transfer Mechanisms at Electrode-Electrolyte Interfaces of Li-ion Batteries
PI: Bilge Yildiz, Department of Nuclear Science and Engineering (NSE) and DMSE

Project 2.2—Mid- & LW-Infrared Detector Arrays on Flexible Substrates
PIs: Tomás Palacios, Department of Electrical Engineering and Computer Science (EECS); Dirk Englund, EECS; and Jing Kong EECS

Project 2.3—Room Temp LWIR-THz Detection via E-field Enhancement Induced QD Upconversion
PIs: Moungi Bawendi, Chemistry; Vladimir Bulovic, EECS; Keith Nelson, Chemistry; and Adam Willard, Chemistry

Project 2.4—Particulate Fluid Fiber Processing for Fabric Communications
PIs: Yoel Fink, DMSE and EECS; and John Joannopoulos, Department of Physics (Physics)

Project 2.5—Nano-plasmonics for Soldier Applications
PIs: Marin Soljačić, Physics; Jing Kong, EECS; and Steven Johnson, Department of Mathematics (Mathematics) and Physics

Strategic Research Area 3: Transformational Nano-optoelectronic Soldier Capabilities

Project 3.1—Solid State Power Generation at Millimeter Scales
PIs: Ivan Celanovic, ISN; Marin Soljačić, Physics; and Peter Fisher, Physics

Project 3.3—Nanophotonics-Enhanced Systems for the Soldier
PIs: Steven Johnson, Mathematics and Physics; Marin Soljačić, Physics; and John Joannopoulos, Physics

Project 3.4—Applications of Novel Topological Phenomena
PIs: Liang Fu, Physics; Nuh Gedik, Physics; and Marin Soljačić, Physics

In addition to these core projects, the ISN supports projects funded through Military Interdepartmental Purchase Requests (MIPRs), which allow US military services and agencies to directly fund targeted research of special interest to them, and collaborative projects with MIT Lincoln Laboratory (LL). Also, the ISN uses MIT cost-sharing and discretionary funds from industry to support several seed projects, which allow the ISN to respond swiftly to emerging needs and rapidly developing opportunities.

Funding

Funding for ISN basic research was more than $150 million over its first 15 years, with the majority of these funds having been dispensed through a series of five-year contracts—ISN-1 ran from 2002 to 2006, ISN-2 ran from 2007 to 2012, and ISN-3 ran from 2013–2017—that were administered by the US Army Combat Capabilities Development Command Army Research Laboratory-Army Research Office (DEVCOM ARL-ARO). Nearly $20 million in additional funds were provided by the Army to facilitate the

transitioning of promising outcomes of ISN research to the next stages of development, with the bulk of these funds distributed to ISN partner companies and Army science and technology (S&T) installations. These resources—which were categorized as US Department of Defense (DOD) budget activity 6.2 (applied research)—were discontinued by the Army in fiscal year 2017.

Following extensive reviews leading to approval by the Army in 2017, ISN-4 began in January 2018. Unlike with previous renewals, when a single new contract was issued, ISN-4 has two core funding instruments. The indefinite delivery/indefinite quantity (IDIQ) procurement contract for ISN-3, which was extended through 2022, continues Army funding of the ISN UARC including support for the ISN headquarters, management and outreach, and research enrichment including laboratory facilities at 500 Technology Square (Building NE47). As a UARC, the ISN is able to accept external funding from the Army and the broader US DOD for additional projects beyond the core ISN-4 portfolio. Additionally, there is a separate Cooperative Agreement (CA), new with ISN-4, that was established to fund the research projects that make up the core ISN-4 research portfolio. The CA is structured with the intent of simplifying Army administrative procedures to enable Army scientists to visit MIT more easily for collaborative work with ISN researchers. Due to a cascading series of funding cuts not tied to performance that began during ISN-3, the total amount of Army funding from DEVCOM ARL-ARO for ISN-4 core work is projected to be approximately $23.9 million over the five years from 2018 to 2022. Projected total core Army funding for Year 4 and Year 5 of ISN-4 is estimated at $4.3 million per year, down from a nominal average of $10 million per year during ISN-1.

In addition to its core funding through ARO, the ISN continues strong efforts to expand and diversify its sources of funding in order to strengthen its research portfolio and augment its contributions to S&T for the Soldier and other US warfighters. Examples of these sources include MIPRs from laboratories within DEVCOM such as the Army Research Laboratory (DEVCOM ARL) and the Soldier Center (DEVCOM SC). Moreover, with strong support from the MIT Vice President for Research (VPR) and MIT Lincoln Laboratory leadership, the ISN and LL have been developing new collaborative research projects that engage MIT faculty, including faculty previously not affiliated with the ISN and LL professional staff members. These combined efforts increased total ISN research funding, both core and non-core, to approximately $7.3 million for fiscal year 2020 (FY2020) and approximately $10.0 million for FY2021.

One notable initiative that the ISN had hoped would bear fruit was the partnering ISN personnel with broader MIT community members in a competed opportunity to manage a University Consortium on Applied Hypersonics (UCAH)—sponsored by the newly-founded Joint Hypersonics Transition Office (JHTO) within the Office of the Undersecretary of Defense for Research and Engineering. A seven-person Coordinating Team was formed to steer MIT's response to this opportunity. Three of the team's members were Radovitzky, Peters, and Hadley. With the approval and backing of the VPR, this team synchronized MIT's partnering with a group of universities led by Texas A&M University. Ultimately, Texas A&M was successfully chosen to manage the UCAH. MIT made the decision to remove itself from the consortium due to concerns

over restrictions on the citizenship of participating researchers. Discussions to explore a mutually agreeable pathway for MIT participation have continued. In June, Rodney Bowersox, UCAH director and professor of Aerospace Engineering at Texas A&M, Gillian Bussey, inaugural director of JHTO, and Colleen Mazzeo Leslie, assistant provost for research administration at MIT, discussed approaches that would enable MIT main campus and LL to participate in the UCAH. While additional work is still needed to determine which pathways would allow MIT's and ISN's participation moving forward, this conversation produced positive developments.

Planning for ISN-5

In spring 2021, the ISN administration began the process of soliciting project proposals for potential funding under its fifth five-year contract, ISN-5, with an expected performance period of January 2023 to December 2027. In all, the ISN received 50 project proposal abstracts (PPAs) from research teams featuring a total of 49 different members of the MIT faculty and professional research staff, representing 13 different MIT academic departments plus the ISN. Based on internal reviews of these PPAs, and in consultation with the US ARO program manager for the ISN (ISN PM), 21 project proposal white papers (PPWPs) were invited and 20 were received. The PPWPs are sent by the ISN PM to subject matter experts from academia and the Army S&T community for evaluations that will be returned in time for communication of the review results at an Army's Technical Assessment Board (TAB) meeting for the ISN. The meeting will take place October 27–28, 2021, at which ISN leadership will present on existing ISN-4 research and proposed ISN-5 research. At this meeting—currently expected to be held virtually due to continuing COVID-19 pandemic logistical and administrative complexities within the Army—the PIs attached to each PPWP will have the opportunity to present on their proposed projects. With projected flat core funding levels of approximately $4.3 million per year for each year of ISN-5, it is expected that the ISN will be able to fund 10 to 12 of the PPWPs as full ISN-5 projects. While the final decision on which PPWPs will be selected is the purview of the Army's Executive Steering Board (ESB) for the ISN—co-chaired by the DEVCOM commanding general and the deputy assistant secretary of the Army for Research and Technology—the ESB is expected to strongly value the assessments and determinations of the TAB—co-chaired by the director for technology in the Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology—also known as ASA (ALT)—and the director of DEVCOM ARL.

Army Collaboration

Army research partners are vital to the ISN mission. They collaborate with the ISN on basic and applied research, provide guidance on the Soldier relevancy of ISN projects, and participate in technology transfer (i.e., transitioning, or the technological maturation and scale-up of the outcomes of ISN basic research). A sampling of Army S&T laboratories and centers with which the ISN has collaborated is listed below.

Note that with the 2018 founding of Army Futures Command, the Army embarked on a substantial reorganization and restructuring of its S&T-focused units. In many cases, those groups changed lines-of-report, names, and acronyms. Only the current names and affiliations are included, even if an ISN collaboration predates these changes.

US Army Combat Capabilities Development Command (DEVCOM)

- DEVCOM Army Research Laboratory
    - Army Research Office
    - Computational and Information Sciences Directorate
    - Human Research and Engineering Directorate
    - Sensors and Electron Devices Directorate
    - Weapons and Materials Research Directorate
- DEVCOM Aviation and Missile Research, Development, and Engineering Center
- DEVCOM Command, Control, Communication, Computers, Cyber, Intelligence, Surveillance and Reconnaissance Center
    - Night Vision and Electronic Sensors Directorate
- DEVCOM Chemical Biological Center
- DEVCOM Soldier Center

US Army Corps of Engineers

- Cold Regions Research and Engineering Laboratory
- Engineer Research and Development Center

US Army Medical Research and Development Command

- US Army Institute of Surgical Research
- US Army Medical Research Institute of Infectious Diseases
- US Army Research Institute of Environmental Medicine
- Walter Reed Army Institute of Research

Program Executive Office—Soldier

- Project Manager—Soldier Protection and Individual Equipment

Other Department of Defense and US Government Collaboration

While ISN's first customer remains the Soldier, many ISN research projects are relevant to needs of other government agencies. Collaborations or other interactions have occurred with a number of the Army's sister services and other US government entities, including:

- Camp Roberts (California National Guard)
- Deployed Warfighter Protection Program
- Naval Postgraduate School
- Naval Sea Systems Command
- US Air Force Medical Service
- US Air Force Special Operations Command
- US Department of Agriculture
- US Food and Drug Administration
- US Special Operations Command
- Walter Reed National Military Medical Center

Industrial Collaboration

Industry partners are critical to the ISN mission, helping turn innovative results of basic research into real products and scale them up for affordable manufacture in quantities needed by various end users. Current ISN industry partners are:

- Nano-C
- Raytheon Technologies
- Veloxint
- Xtalic

In addition to these formal members of the ISN industry program, the ISN regularly interacts with other companies and organizations. Examples include:

- Advanced Functional Fabrics of America (AFFOA)
- Brigham and Women's Hospital
- Kinalco
- Massachusetts General Hospital
- Mesodyne

Transitioning

The ISN places a strong emphasis on fundamental research. However, the transitioning, or technological maturation, of promising outcomes of that research is also a crucial component of the ISN mission. To this end, the ISN works with the Army, industry partners, startups, other companies, and LL, and with the MIT Technology Licensing Office—now part of the MIT Office of Strategic Alliances and Technology Transfer (OSATT)—to help ensure that promising ISN innovations mature beyond lab scale and benefit Soldiers, other warfighters, and first responders as rapidly and efficiently as possible. The ISN is pleased to count John R. McConville, a DEVCOM ARL-ARO Technology Transfer Officer (TTO), among our full-time headquarters team. It is the TTO's charge to help maximize the effectiveness and efficiency with which ISN technologies progress from the laboratory bench to more advanced stages of development with particular emphasis on bringing new technologies to the Soldier and other US Warfighters. Furthermore, McConville acts as the ISN's *de facto* Army Liaison, providing in-house guidance on a vast array of issues related to navigating the complexities of the US Army and the broader DOD.

Throughout its history, the ISN has been the source of several highly important technology transitions. One very notable transition is the Advanced Functional Fabrics of America Manufacturing Innovation Institute. Founded in 2016 by the US DOD as a part of the National Network for Manufacturing Innovation and based on a proposal spearheaded by MIT, AFFOA is rooted in ISN research that was led by ISN-affiliated MIT faculty member Yoel Fink, professor of DMSE who became AFFOA's founding CEO. In June 2017, AFFOA unveiled its dedicated facilities a short walk from the main MIT campus, along with a sampling of prototypes containing advanced optoelectronic fiber devices. AFFOA currently counts among its leadership team Alexander Stolyarov, CEO, and Mihai Ibanescu, director of Systems Engineering, who contributed to ISN research as PhD students and postdoctoral researchers.

Since the start of the current ISN-4 funding cycle in 2018, more than 35 US patents have been awarded on intellectual property enabled by ISN research. From its founding in 2002, ISN intellectual property has been licensed for further development or commercialization by at least 39 different companies. Moreover, as many as ten startup companies were founded specifically to transition innovations from the ISN Soldier Design Competition over the 16 years of its operation.

Sampling of ISN Research Accomplishments

ISN-developed Optoelectronic Fibers Installed on the International Space Station

A fabric panel woven from piezoelectric fibers developed through ISN research was installed on the exterior of the International Space Station. The purpose of this first installation is wear-testing of the material in the harsh Low Earth Orbit environment—something that is also being examined on Earth using the lab-scale ISN Laser-Induced Particle Impact Test (LIPIT) facility, which launches microscopic particles at extraordinary speeds toward a target substance. A planned fall 2021 launch will include a fully functioning fiber array for further capabilities testing in space. Such fibers could result in the application of arrays of advanced sensors to future space—and Earth—vehicles,

structures, devices, and even uniforms. Ultimately, they might impart the capability to detect impacts by cosmic dust and other objects, add the possibility of touch sensitivity to space suits, perceive the incidence of blast waves, and function as precise and directional microphones that can not only detect sounds from outside—like gunshots—but also inside—like a Soldier's heartbeat. The resulting technical article was featured in the Proceedings of SPIE following its presentation at the 2020 *SPIE Smart Structures + Nondestructive Evaluation* virtual event, and was the subject of an MIT News 3 Questions segment and also an Army news release that was featured on the Army homepage.

Tough Biofilms Grown from Kombucha Mother-Like Culture May Lead to Advanced Sensors

Using ingredients similar to SCOBY (symbiotic culture of bacteria and yeast)—the "mother" used to ferment kombucha tea—ISN-affiliated MIT faculty working with colleagues from MIT and Imperial College London have developed a tough, easily and inexpensively manufactured, enzyme-embedded cellulose that could eventually be used for environmental sensing and in self-repairing materials. Furthermore, by incorporating yeast into the cellulose, the team's advance may lead to the ability to purify water, create packaging that signals when it has become damaged, or perform a variety of other functions. This research, detailed in a *Nature Materials* article, was the subject of stories on MIT News and *Stars & Stripes* and in an Army news release that was featured on the Army homepage.

New Design of Perovskite Solar Cells Significantly Improves Efficiency

A team of ISN-affiliated faculty and researchers achieved near-record efficiencies for perovskite solar cells using a processing technique that can be applied to current manufacturing methods, an important advance that could lead to more efficient lightweight and flexible portable energy solutions, especially when long lifetimes are not needed. These short-lifetime solutions could have particularly strong impact on military applications, for such purposes as temporarily deployed equipment and short-term missions, and longer lasting perovskite cells remain an objective. This research was detailed in a *Nature* article and described in an article featured on MIT News.

Spinning Polyethylene into Advanced Wicking Fabrics:

An ISN-affiliated MIT research scientist and colleagues developed a process to make mildly hydrophilic fibers and fabrics from polyethylene, long thought an unsuitable material for clothing due to its normal hydrophobic nature. Although widely used for everyday applications such as plastic bags and cling wrap, low-density polyethylene is often discarded rather than recycled and can be more difficult to recycle than some other plastics. Transitioning such materials more easily to usable goods could have significant environmental benefits, and the achievement could lead to new high-performance fabrics for applications ranging from athletic wear to space suits with a lower ecological impact than those constructed from newly synthesized materials. Detailed in an article in *Nature Sustainability* this research was featured in an MIT News article on the MIT homepage, and was also the subject of BBC News and United Press International (UPI) stories.

Encapsulating Bacteria for Better and Safer Environmental Sensing

Engineered bacteria can serve a host of sensing functions, like monitoring bodies of water for contamination, but these modified organisms can pose a risk when released into the environment. Researchers led by a pair of ISN-affiliated MIT professors are working on a new means of preventing gene exchange by encapsulating bacteria in a hydrogel material. The process involves embedding the bacteria in a sphere of alginate hydrogel and then covering that sphere in a tougher hydrogel with tiny pores allowing analytes in but not genetic material out. This research was the focus of an article by MIT News following its publication as a technical paper in *Nature Chemical Biology*.

Tough, Fatigue-Resistant Hydrogel Mimics a Lobster's Underbelly

A team led by ISN-affiliated PIs and a DEVCOM ARL researcher stationed at the ISN has synthesized a nanofibrous hydrogel that mimics the flexible but ultra-tough underbelly of a lobster, previously determined by another MIT group to consist of the toughest known natural hydrogel. Like its natural counterpart, the new material consists of interconnected hydrogel fibrils that are roughly 1/100 the diameter of a human hair aligned in a flat film. Its mechanical properties tested multiple ways—including using the ISN LIPIT array—the synthetic hydrogel was found to be approximately 50 times more fatigue resistant than conventional nanofibrous hydrogels. The new substance could lead to artificial tissues, smart clothing, and lightweight protective materials. This research, detailed in a technical article in the journal Matter, was featured in an MIT News article promoted on the MIT homepage, as well as on the homepage of the National Nanotechnology Initiative. It was also the subject of stories in *New Atlas*, *Science Times*, and a number of other science-focused news outlets and websites.

Advances in 2D Materials May Lead to Smaller Microchips

A team including scientists and engineers from MIT, UC Berkeley, the Taiwan Semiconductor Manufacturing Company, Lawrence Berkeley National Laboratory, and others has developed a new way of linking 2D materials with the traditional electronic components of today, potentially clearing a major hurdle to the adoption of these materials, which could lead to faster, more efficient, and smaller microchips. While the continued development and scale-up of these advances will likely take years, the researchers believe that they could be applicable to additional scientific applications immediately. Detailed in a Nature research publication, this work was also featured in an MIT News article.

Programmable Fiber Comprising Memory, Sensors, and Neural Network

An MIT team working with researchers from the Rhode Island School of Design and Harrisburg University has realized the first digital fiber. Capable of sensing, storing and analyzing data, and inferring activity, the fiber contains memory, temperature sensors, and a trained neural network. With continued advances and concurrent research, this achievement could lead to a new era of computing fabrics for military uniforms and civilian clothing. This research, detailed in Nature Communications received a large amount of attention, with articles published in MIT News, *UPI*, *Stars & Stripes*, *Forbes*, *Army Times*, and *Popular Mechanics*.

Nanoarchitected Carbon Structures More Resistant to Impact than Kevlar

A team including scientists and engineers from MIT, Caltech, and ETH Zürich has designed, fabricated, and tested a remarkable carbon-based nanoarchitected structure that holds promise for future lightweight armors, blast-resistant materials, and protective coatings, as well as a slew of other applications. Detailed in a *Nature Materials* article, the structure—geometrically called a tetrakaidecahedron—was manufactured via a two-photon lithography process and then tested using the ISN's LIPIT facility. This testing step was crucial to the work, because although similar nanotrussed structures have been manufactured before, they have not been tested under the rapid deformation provided by LIPIT that is vital to understanding a materials behavior under ballistic impact conditions. The results of the experiments revealed that the structure was much more efficient at absorbing the force of impact than the same mass of Kevlar would be. This work was the subject of significant media interest: it was the focus of articles in MIT News, Caltech News, *TechCrunch*, and *Army Times*; an Army news release on the research was presented on the homepage of the US Army; and a video segment is in preparation for broadcast on the Armed Forces Network.

Outreach Activities

Visits and Meetings

Under normal circumstances hundreds of people visit the ISN each year for briefings and tours. Prior to the scale-back of MIT campus operations due to the COVID-19 pandemic, the ISN hosted visits by the DARPA Service Chief Fellows, Army Futures Command CTO, former astronaut Dr. Ronald Sega, and a delegation of senior professional staff members from the House and Senate Armed Services Committees.

During the COVID-19 pandemic-induced reduction in campus operations, the ISN was forced to decline a number of high-profile requests to visit, including one from the ASA (ALT). However, ISN leadership was able to participate in several remote events including participation by the ISN director as a plenary panelist at the virtual National Nanotechnology Initiative Strategic Planning Stakeholder Workshop: Charting the Path Forward, January 11–13, 2021, as well as a large number of technical and coordinating meetings with the aim of growing and strengthening research initiatives.

In the future, ISN leadership looks forward to engaging in a more traditional manner with guests and sponsor representatives but is excited for the prospect of continuing what have now become more common meetings with far-flung colleagues without the necessity of travel allowed for by software solutions such as Zoom and Microsoft Teams, including potentially impromptu meetings that can enable rapid consideration of important topics by multiple parties.

Soldier Design Competition

Regrettably, despite its many years as a popular and successful activity, it became necessary in August 2020 to permanently cancel the Soldier Design Competition as an ISN event due to the same budget cuts that required the cancellation of ISN-4 projects 3.2 and 3.5.

Contributions to the MIT Community

Very recently, the ISN has received a fiber spooler from an Army colleague at DEVCOM SC. Used in conjunction with an ISN fiber extruder, the new spooler could prove extremely useful in research involving polymer fibers.

The use of much of this equipment, and other available research facilities at the ISN, is expedited by a newly redesigned intranet website with increased usability and functionality for scheduling.

Response to COVID-19

After March 17 and for a significant portion of 2021, activities at ISN facilities continued in an extremely reduced manner, with some gradual increases as MIT and the ISN progressed through the Research Ramp-up process. With the approach of fall—and the new academic year—the ISN administration anticipates and prepares for substantially renewed activities on campus with the goal of full operations on campus beginning in early September 2021.

ISN adherence to MIT protocols, and the development of ISN-specific regulations are the purview of the ISN's DLC Monitoring and Compliance (DMC) Committee charged with overseeing adherence to mandated laboratory regulations, including those regarding capacity, social distancing and wearing of face masks.

The ISN DMC Committee comprises as of July 2021 the following ISN staff members:

- John Joannopoulos, director (ex officio)
- Bill Peters, executive director
- Steven Kooi, principal research scientist
- Amy Tatem-Bannister, laboratory and facilities manager and Environmental Health and Safety (EHS) coordinator
- Donna Johnson, research support associate II and EHS representative
- Nicole Bohn, electron and surface microscopy instrumentation specialist
- Joshua Freedman, assistant director for finance and administration
- Marlisha McDaniels, executive administrative assistant

Franklin Hadley occasionally joins DMC Committee meetings, principally to discuss outward-facing issues, including the presentation of access rules and other COVID-19 pandemic-related policy modifications to the ISN and MIT communities via email and the ISN website, as well as to help plan updates to ISN conferencing facilities and equipment in order for them to properly serve the ISN community in a new paradigm of hybridized meetings blending the in-person with the virtual.

It is expected that, even as campus-based operations are renormalized, the ISN will continue to hold regular DMC Committee meetings to deal with issues regarding laboratory and facilities operations, relating to both the COVID-19 pandemic and other areas of consideration.

Future Plans

The ISN mission remains extremely relevant to the needs of the Soldier, other US warfighters and first responders, and the nation. Over the coming years, ISN will seek to build and further strengthen partnerships with the Army, other US military services and agencies, industry, and MIT Lincoln Laboratory, while adjusting and enriching our fundamental research portfolio to respond to new opportunities and evolving customer needs. Working as an Army-industry-university team, we will continue to perform fundamental research and transitioning to enable a range of innovative capabilities to protect and assist US military personnel and civilians in high risk and dangerous situations.

John D. Joannopoulos
Director
Francis Wright Davis Professor of Physics