Global Good and IV Lab
Inventing for Impact

Translating scientific research into technological solutions for some of the world’s toughest problems
Global Good brings new technologies to life in the ideal invention workspace of the Intellectual Ventures Lab. Collaborating across Lab-based platforms teams, we perform the translational work that applies research-proven science to deliver real-world solutions.

ABOUT GLOBAL GOOD

Every year, millions of people suffer and die in poor countries from causes that humanity has the scientific and technical ability to solve. Funded by Bill Gates and focused on a shared vision with Nathan Myhrvold, Global Good invents technology to solve some of humanity's most daunting problems.

Pursuing this core purpose of inventing for humanitarian impact, we envision a world where no one suffers from conditions or issues that science has the power to prevent or treat, regardless of where they live.

We do this by collaborating with like-minded organizations, forward-looking governments, research institutions, and corporate and private sector partners that can help to bring our inventions to market.

Pioneering ideas are typically developed to serve affluent markets. In contrast, we seek to create and commercialize breakthrough products for launch into low-income economies, serving the people with the greatest needs first. Thereafter, they may eventually be deployed to more developed economies in a “reverse innovation” approach.

THE IV LAB ADVANTAGE

Global Good’s collaboration with the IV Lab provides several unique advantages that help to accelerate the invention process.

Collaborative Inventing. We generate novel solutions via cross-team brainstorming and "Invention Sessions" with leading inventors.

Risk and Agility. Our inventors, scientists, and engineers have creative freedom to take risks, fail fast, and adapt quickly for more rapid development of refined solutions.

Smart Partnerships. Working together with partners worldwide throughout the process, we’re able to provide more effective solutions.
Solving for Gaps in Health and Development

While many organizations seek opportunities to apply existing technical solutions, Global Good’s problem-first approach begins by looking at existing gaps and then seeking to develop new technologies in response to the needs.

**Global Development Technologies**

Our global development work focuses on practical solutions to address gaps in nutrition, food security, and food safety; to mitigate smallholder farm risks from pests, pathogens, and other environmental factors; and to sustainably improve agribusiness value chains with an emphasis on benefitting smallholder farmers and their families.

**Global Health Technologies**

In the area of health, we focus heavily on improving Primary Health Care with an emphasis on strengthening local clinics and their capability to provide more effective care to the community. Our broader concerns include developing solutions for the prevention, management, and elimination of high-burden diseases as well as addressing general health-related risk factors in the home and workplace.

More detail is available via www.globalgood.com.
Our Vision and Big Bets

**Center for In-vitro DIAGNOSTICS**

- Biotechnology Platforms
- Bacterial Viability Detection,
- Lateral-Flow Rapid Diagnostics,
- Microfluidics

**Center for Intelligent DEVICES**

Integrating leading technologies into solutions for global health and development

- Optics, Machine Learning,
- Fluid and Respiratory Systems,
- Electromechanical Devices
  - Thermal Control

**DIAGNOSTICS AND DEVICES**

Advances in global development and healthcare are enabled by improved decision support – accurate assessment of current conditions leading to well-informed remedial actions.

In healthcare, low-income nations are generally unable to provide clinics with sufficient decision support. Medical diagnostics usually require professionally skilled analysis, performed at distant lab facilities that are insufficiently resourced to serve the neighboring populations. Our vision for primary care seeks to enable localized decision support with diagnostic systems that deliver immediate professional-quality test results at the point of care, empowering health workers to provide more effective interventions when needed.

Similarly, in the global development realm, we see how smallholder farmers will greatly benefit from new technologies enabling easier assessment of soil nutrients, grain storage moisture, milk cleanliness, and other key factors for productivity and food safety.

To realize this vision for improved decision support, we are investing heavily in developing new diagnostics, delivered via smart devices, providing automated analysis and results at the local level.

**PRINCIPAL INVESTIGATORS & PLATFORMS**

Principal Investigators (PIs) are senior research engineers or scientists with deep expertise in specialized fields. They co-mingle in the Lab environment and form collaborations to tackle problems. Each PI heads a specifically focused team that can develop and offer “platform” solutions applying a reusable technology capable of being repurposed for multiple practical uses.

While each team will tend to focus on either diagnostics or devices, project activities are often highly integrated across all scientific and technical disciplines in the IV Lab.
Rapid Diagnostics, Microfluidics

Our research in microfluidics and related material sciences focuses on next-generation rapid diagnostics with enhanced sensitivity. The team combines computer modeling with automated empiric assay optimization, paper microfluidics, antibody discovery and optimization, nanoparticle optimization, and signal amplification. Application areas include malaria, tuberculosis, other major infectious diseases, and environmental pathogens.

This team specializes in new applications and improved sensitivity for disease-targeted Lateral Flow Assays (LFAs) in which a drop of sample fluid flows over a chemically treated strip to reveal a diagnosis. While seemingly simple, the science of developing and improving LFAs is actually extremely challenging.

To facilitate this process, the microfluidics group created software to handle the computational complexity of accurately predicting how a proposed LFA design will perform. The new tool helps accelerate progress toward more rapid and accurate diagnosis of several diseases.

Bernhard Weigl, Director, Center for In-vitro Diagnostics
Prior to IV Lab, Bernard led the PATH Diagnostics Group, overseeing programs funded by NIH, USAID, and the Gates Foundation. He has been the PATH Portfolio Lead for noncommunicable disease diagnostics and has served as Director of the NIH-funded Center for Point-of-Care Diagnostics for Global Health. At the University of Washington, he continues as an Affiliate Professor in Bioengineering, and was scientific cofounder of Micronics, Inc. He received his M.Sc. and Ph.D. from Austria’s Karl-Franzens-University Graz and completed post-doctoral studies at the University of Southampton and the University of Washington.
Bacteria Viability Detection

The Rapid Bacterial Viability Detection group invents and integrates techniques for quickly determining the viability of microorganisms. In performing this work, they apply the use of cell culture, staining, NAAT, phage-based detection, metabolite detection, microfluidic device design, and digital assay methods. Current application focus areas include tuberculosis, sepsis, and water quality.

Whether tests are being developed for medical diagnosis or environmental safety, obtaining immediate results is critically important. This group develops practical technology applications that can detect specific harmful bacteria strains in far less time than previous diagnostics.

Methods for detecting *E. coli* in water supply samples typically require a day or more to obtain results via specialized lab processes and professional expertise. This group’s *E. coli* detection project aims to provide test results in just a few hours without the need for any specialized workspace or personnel.

The process is accomplished through a lab-on-a-chip system that automates laboratory steps to detect *E. coli* in environmental samples using genetically modified viruses that induce the expression of a visible signal in the target bacteria. The stepwise procedure is performed in a microfluidic system, wherein tiny channels direct the flow of liquids, such as a test sample and additives, through the entire diagnostic sequence.

**Kevin Nichols, Principal Investigator**

Kevin P. Nichols, Ph.D., is a bioengineer with a broad background in assay development. Besides heading the Rapid Bacterial Viability Detection work, he has also led several lateral flow assay development efforts at IV Lab. Previously, Kevin was a staff scientist at Argonne National Laboratory, working on microfluidic analytical chemistry systems. His educational background includes a postdoctoral appointment in the chemistry department at the University of Chicago, a Ph.D. from the MESA+ Institute for Nanotechnology, and an undergraduate degree in bioengineering from Cornell University.
Biotechnology

This group harnesses advances in nucleic acid detection, protein engineering, and enzymatic signal amplification. Current work efforts include developing next-generation molecular diagnostics to provide more information in less time and developing tools that can improve food quality. Applications include detecting HPV, detecting mycobacterium tuberculosis, determining bacterial load in food products, and removing food toxins.

The Biotechnology team supports development of low-cost tools to rapidly detect pathogen DNA – working in conjunction with platform technologies that can potentially diagnose multiple infectious diseases.

One of the first tests in development will detect human papillomavirus (HPV), which causes 99% of cervical cancer cases and is responsible for 200,000 deaths every year in poor countries. In developed nations, the Pap smear has drastically reduced cervical cancer mortality. It is performed at routine intervals in the woman’s life, monitoring for slowly progressing cellular changes. However, the Pap smear is not suited for low-resource settings where women are rarely tested and are unlikely to return for test results or treatment. The new HPV test aims to immediately identify disease-causing DNA, decreasing the need for frequent testing. With results provided in one hour, women could receive same-day screening and treatment.

Damian Madan, Principal Investigator
Before joining IV Lab, Damian was a senior scientist at Echelon Biosciences where he developed a suite of products that primarily serve oncology drug discovery and in-vivo imaging markets. Damian received a B.A. from Willamette University in biology and philosophy and a Ph.D. in molecular biology from Princeton University where he studied cellular machines involved in protein folding. Damian was also a post-doctoral fellow at the University of British Columbia, where he studied the molecular causes of Huntington’s disease.

DNA is extracted and amplified for the detection of HPV.
Comprised of electrical engineers and software and algorithm developers, this group’s research areas include optical systems, data acquisition systems, complex data analysis, machine learning, and artificial intelligence (AI). Their core research includes developing optical hardware and machine-learning technologies as well as signal processing, photonics, ultrasound, spectral imaging, novel imaging, and biosensors.

This team took a lead role in creating an automated microscope that can optically detect malaria-infected cells on blood sample slides. They “trained” the new artificially intelligent system using thousands of actual slides containing malaria-infected cells. Working from initial input instructions and machine learning algorithms, the software ultimately became capable of detecting malaria as accurately as a trained medical professional. Project success hinged on the ability to obtain the largest-ever digital library of malaria slide imagery through Global Good relationships with health agencies worldwide.

Other projects that apply this group’s expertise include pulmonary ultrasound diagnostics, cervical cancer screening, and detecting falsified drugs using near-infrared spectrometry in a hand-held device.

Benjamin Wilson, Director, Center for Intelligent Devices
Ben Wilson’s work at Intellectual Ventures Laboratory is focused on optical devices and advanced algorithms as well as machine learning for image and spectral interpretation. As an IV Lab scientist, he has been a key contributor to more than thirty scientific articles and conference papers covering a wide range of optics-related topics. Prior to joining IV Lab, he worked on research teams at the University of Washington and Pacific Northwest National Laboratory. He received his Ph.D., M.S., and B.S. degrees in Electrical Engineering from the University of Washington.
Fluid and Respiratory Systems

The Fluid and Respiratory Systems group provides expertise in fluid dynamics, transport phenomena, mechanical engineering, chemical kinetics, and multi-phase material behavior. Areas of focus include prevention and treatment of respiratory diseases such as pneumonia through an efficient therapeutic oxygen mask and an oxygen delivery system that mitigates otherwise unreliable oxygen supply.

This team’s work includes improving clinical delivery of oxygen to infants – seeking to significantly reduce deaths caused by pediatric pneumonia. To support oxygen delivery mask studies, the team created scale models of a wide range of infant face shapes and sizes based on measurements of actual children. They then modeled and studied mask designs using a lung simulator and specialized sensors to record concentrations of oxygen and carbon dioxide as well as pressures and flows. This work led to the development of an improved oxygen delivery cannula (nose mask) with more than double the efficiency of other masks.

Oxygen supply via high-pressure cylinders is typically unreliable in poor economies, and electrical oxygen concentrators become unavailable when the grid fails. This group has developed a system that uses an oxygen concentrator to meet patient needs and concurrently stores oxygen in a low-pressure reservoir for use in case of power outage.

Flow analysis supports oxygen mask improvement.

Daniel Lieberman, Principal Investigator

Dan is a mechanical engineer by training with 20+ years experience investigating thermo-fluid systems in many areas including cryogenics, respiratory systems, chemically reacting flows, and propulsion devices. Prior to IV Labs, he managed a post-failure-analysis team at an engineering consulting firm. He has held part-time faculty positions at the University of Southern California and École des Métiers de l’Aérospatiale de Montréal. He holds a Ph.D. and M.S. in Aeronautics from California Institute of Technology, a bachelor’s degree in engineering from McGill University, and is a registered Professional Engineer (PE).
Thermal Control

The Thermal Control group creates technical solutions for projects requiring precision temperature control. Their work focuses on developing and maintaining a knowledge base of thermodynamics, thermal design, thermal control, and systems engineering as applied to topics such as the vaccine cold chain, biospecimen transport, and related logistics. They also work on thermal-factor-dependent clinical lab systems, such as rapid culture systems.

This team works on projects addressing the need to maintain cold temperature conditions in warm climates, such as for storage and transport of certain medical supplies or perishable foods. However, maintaining higher temperatures may also be needed, as seen in the microbial culture incubator to provide stable incubation temperatures in low resource settings with unreliable power. Additional projects seek improved methods to appropriately dry and measure dryness in agricultural products to reduce post harvest loss and increase smallholder farmer income. To test device prototypes, this group uses IV Lab environmental chambers. These room-size spaces can replicate ambient conditions from 5 to 70 degrees Celsius and 5 to 95 percent relative humidity. For example to simulate sub-Saharan climates, they can provide an ongoing daily cycle of 43 °C daytime and 25 °C at night.

Michael Friend, Principal Investigator
Michael’s work includes the development of the Arktek passive vaccine storage device and the solar-powered Arktek SDD. Other work includes the affordable microbial culture incubator, milk chilling solutions for smallholder farmers, livestock vaccine cold chain solutions, and agricultural crop drying and moisture measurement. With more than 30 years’ experience spanning nuclear fusion, optical sensors, lasers, medical equipment, and aerospace, Michael has worked for companies large and small. He received a B.A. in mechanical engineering from Cornell and an M.S. in biomedical engineering from the University of Virginia.
This team focuses on electromechanical and micromechanical systems, applying advanced CAD, simulation, testing, and systems engineering. Their many projects include a vector-control door, an efficient water pump for smallholder farmers, and specialized healthcare-related inventions. Additionally, they provide integrated support for several other Lab group projects such as for vaccine cold storage and pediatric oxygen supply.

The Electromechanical group performs all phases of creating new devices and systems, from initial design concepts to field testing and follow-on iterations.

The group’s mosquito-blocking door-and-window project aims to reduce malaria infections in areas where mosquitoes are the primary carrier. Cross-team brainstorming generated several design ideas, which were further refined in CAD software. Working closely with the Lab’s Precision Fabrication group, the team custom built selected concepts of the vent-screen panels. The completed doors and windows were subsequently shipped to The Gambia, West Africa, for field trials to evaluate design effectiveness and inform follow-on design improvements.

**Tola Marts, Principal Investigator**

Tola started his career building software as an entrepreneur after receiving a B.S. in mechanical engineering from the University of Minnesota in 1992. He moved to Washington in 2003 to help build rockets for Jeff Bezos’ space exploration company, Blue Origin, and in 2012 he joined IV Lab. His first project was bringing the Arktek passive vaccine storage device to production. In the role of managing advanced-device work at IV Lab, he oversees mechanical and electrical engineering support for the global health and development portfolio groups at Global Good.
Our Invention Environment

CORE FACILITIES
The 87,000 square-foot IV Lab building houses several specialized workspaces, ready and available to support all phases of development work – from exploratory experimentation to prototype fabrication and eventual testing of devices and processes. Focused areas in the Lab include • an advanced physics lab • an instrument fabrication shop • a biotechnology lab • a photonics lab • an electronics lab • a mechanical and micromechanical engineering lab • a mosquito insectary • and other science and engineering workspaces.

PRECISION FABRICATION
The Scientific Instrument Manufacturing and Testing Group (SIMTG) brings several decades of collective engineering and manufacturing experience to IV Lab’s fully equipped shop. With advanced capabilities, such as 3D printing, water-jet cutting, electrical discharge machining, and multi-axis NC milling, they are able to design and fabricate complex customized research instruments and quickly produce new device-design prototypes. This is particularly valuable for Global Good’s agile approach to iterative design.

PROFESSIONAL STAFF
More than 100 Intellectual Ventures employees work in the IV Lab space. A majority of the team members hold advanced degrees and have previous research experience in educational or commercial settings. IV Lab staff also often collaborate with external partners in industry, government, and academia. Our Lab-and-Global-Good teamwork is well served by the flexibility to shift staff and priorities among projects at various stages of development according to evolving needs.
IV Lab often provides foundational research and development for the incubation of new stand-alone companies. Spinouts built on internally developed technologies include TerraPower (nuclear energy), Kymeta (satellite communications), Evolv (security scanning), Echodyne (compact radar), Modern Electron (electrical power), and Pivotal Commware (holographic broadband). A few of these companies continue to reside in the IV Lab building – separately defined entities in the Lab space and customers of available Lab services. Additionally, some IV business units have their own dedicated spaces in the Lab, outfitted with specialized equipment according to their needs.

Here are a few examples of groups who have been located in the building:

**TerraPower**, one of the first ventures launched with Lab support, employing specialized fabrication capabilities of the Lab’s precision instrumentation group

**Modern Electron**, pioneers in new energy technology, dedicated to generating affordable, modular, and reliable electricity

**Modernist Cuisine**, a food-science focused group with the world’s most advanced culinary research kitchen

**The Advanced Physics Laboratory** leads research in partnership with private and public institutions to push the boundaries of science. Projects include high-current cold-electron sources, new classes of X-ray sources and detectors, and SiC-based MEMS devices for microfluidics and biosensing applications. They also work on the synthesis and growth of large-area chalcogenide semiconductors and are creating devices to apply the unique properties of this class of materials. Future research work may include direct thermal energy conversion and storage.
The IV Lab came into existence when Intellectual Ventures founder and CEO Nathan Myhrvold envisioned a lab space where team members could experiment and build upon their inventive concepts. And it grew from there. Within just a few years, Global Good was in full swing and was collaborating with the Lab on an increasing number of humanitarian projects. Early successes included the Mazzi milk can and the Arktek Passive Vaccine Storage device, which ultimately won a USPTO Patents-for-Humanity award. Many Global Good inventions have since come to market, with even more in process, as our work at Intellectual Ventures Laboratory continues to thrive and grow. Looking to the future, we’re continuing to develop new technology platforms that will further expand our capacity to invent solutions for those who need them most.
“The tech industry has almost entirely been about making tools and toys for rich people. We sat down and thought, what are some of the ways we could direct technology to the poorest people on Earth... to transform the lives of people who need their lives transformed?”

— Nathan P. Myhrvold