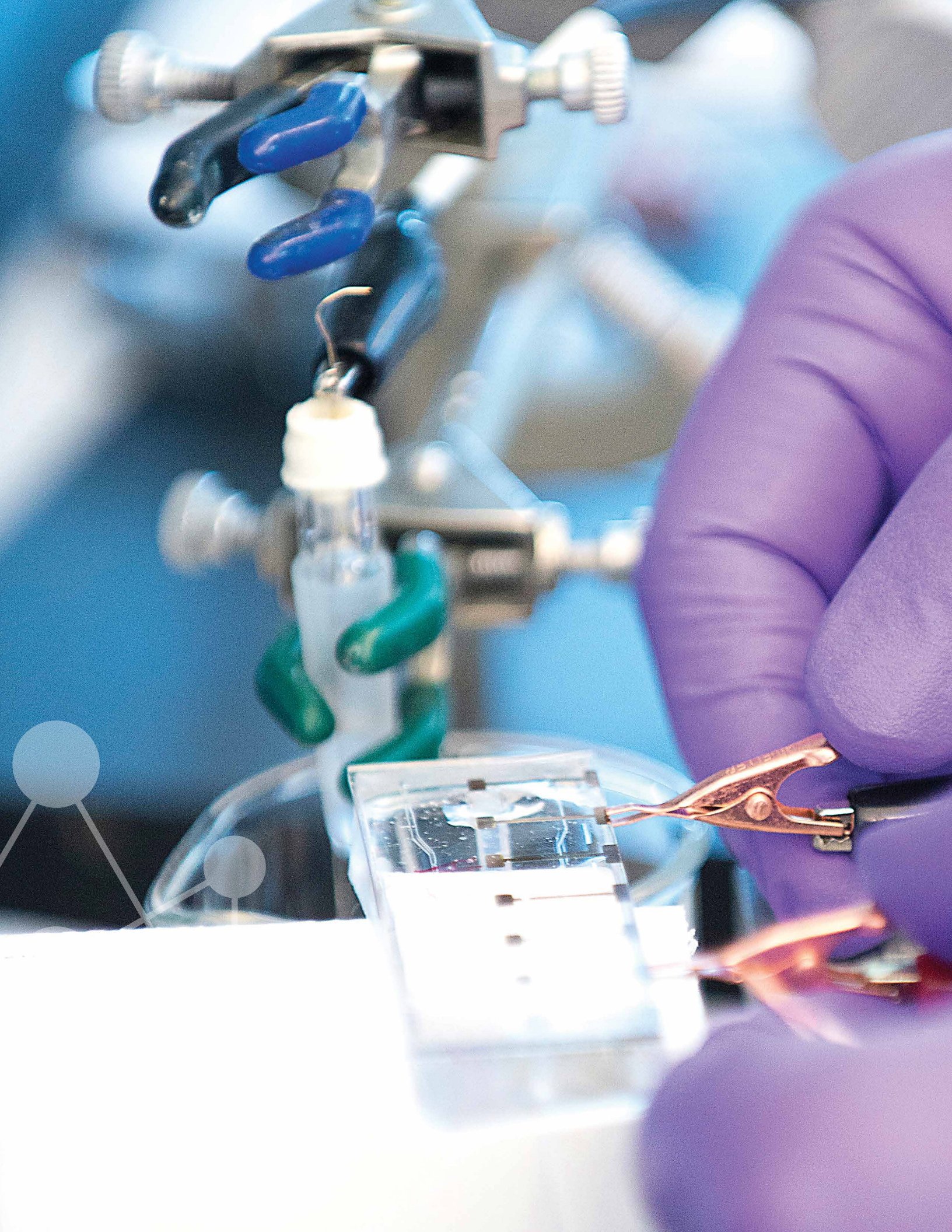
2015 Annual Report

USTAR

UTAH'S TECHNOLOGY CATALYST



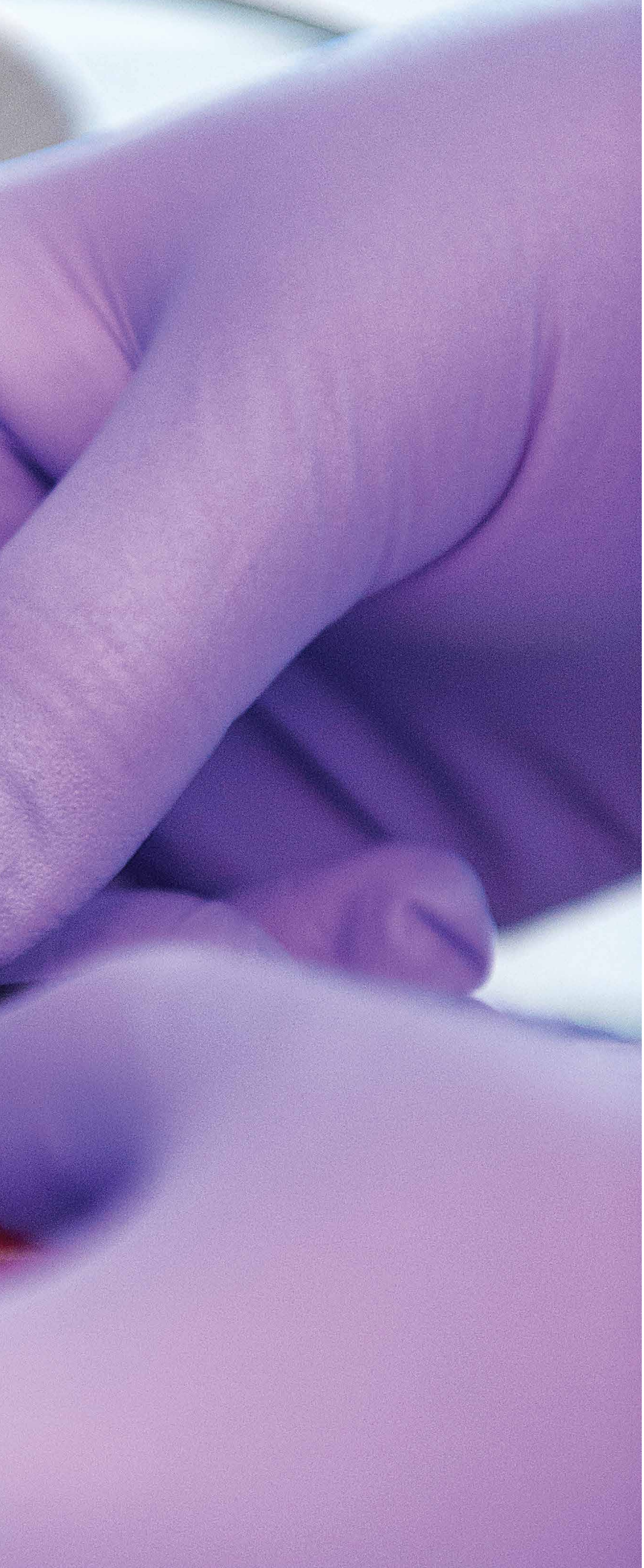


TABLE OF CONTENTS

OVERVIEW

USTAR's Mission and Vision 4
Chairman's Message 5
Accolades 6

TECHNOLOGY ECOSYSTEM

Utah's Vibrant Tech Ecosystem 7
Year In Review 8
Governing Board of USTAR 12
USTAR Leadership 16

SEED

Research 18
USTAR Researchers 19
University Leaders 46

GROW

Core Facilities 50
Sorenson Molecular Biotechnology Building 51
USTAR BioInnovations Center 52
University Commercialization 54
Outreach 55
Outreach Directors 56

THRIVE

Engaging with Industry 58
SRI Assessment/Recommendations 59
MOU with KU Leuven 61
Partners 64
Letters of Support 65

EPILOGUE

Summary Data for Audit 70
Audit Report 76
USTAR Response to Audit 100

USTAR

USTAR OVERVIEW

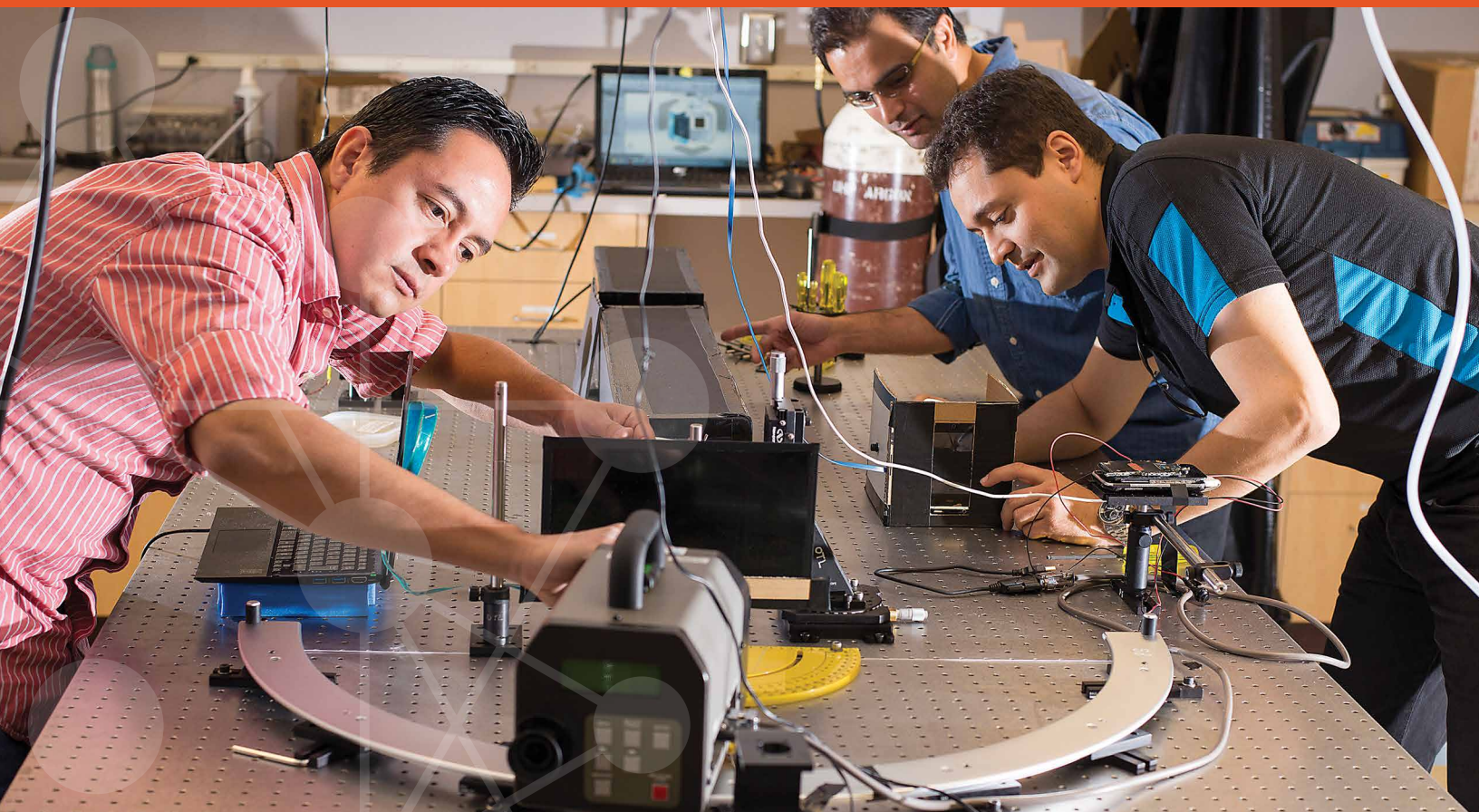
The Utah Science Technology and Research Agency (USTAR) was established in 2006 through the leadership and vision of the Utah Legislature and the Governor to leverage science and technology innovation in support of Utah's economy. The initial focus of USTAR was recruiting world class faculty to the State's research universities, the University of Utah (U of U) and Utah State University (USU). The recruitments expanded expertise in the areas of Life Science, Renewable and Traditional Energy, Nano and Microelectronics and Big Data. In addition, USTAR invested significantly in unique shared facilities such as the nanofabrication facility, the only bio hazard 3+ facility in the State and a life science incubator. In addition to expanding the capacity at the research universities, USTAR established a statewide Technology Outreach Innovation Program (TOIP) which focuses on technology development, mentoring and collaboration to strengthen the technology ecosystem in the State.

VISION *Utah will lead the nation as the best performing economy, and be recognized as a premier global destination.

MISSION To create a technology ecosystem that enables ideas to seed, grow and thrive. USTAR's diverse portfolio of investments will:

1. Recruit and retain top researchers to the State's research universities
2. Support tech entrepreneurs through training, funding, incubator and accelerator programs
3. Broker technology transfer by connecting capital, management and industry

*Adapted from Governor Herbert's vision for the State's economy



CHAIRMAN'S MESSAGE

Dear Legislators, Stakeholders and Industry Partners,

As the Chairman of the Utah Science Technology and Research Agency (USTAR) Governing Authority, it is my pleasure to present you with our annual report for fiscal year 2015.

Over the past year, USTAR has undergone significant strategic, programmatic, functional and cultural shifts. Sweeping changes in USTAR's legislation in 2014 and new appointments to the USTAR Governing Authority ignited a wildfire of change in the strategic, programmatic and organizational components of USTAR. The adoption of a new mission statement – USTAR will create a technology ecosystem that enables ideas to seed, grow, and thrive – aligns the organization's mission with the original legislative intent, and provides the framework for restructuring the organization to meet these goals.

Throughout the past year, we have focused on assessing the technologies in the current portfolio, establishing clear processes and procedures to assure transparency and accountability in all USTAR activities and aligning USTAR staff to meet mission needs. This work has resulted in increased transparency and accountability on financial and performance measures. In addition, we have implemented new methods for analyzing the existing technology portfolio in terms of technical maturity, market potential and business planning, providing a more analytical approach to funding decisions.

In November of 2014, USTAR held its first annual meeting, Confluence: Where Research Meets Commercialization. The two-day event provided the Governing Authority and staff an opportunity to review all USTAR research teams, their research progress, commercialization prospects and planned efforts. We anticipate continuing this informative meeting annually, inviting stakeholders, industry partners and legislators to participate.

The innovative model of USTAR for supporting technology commercialization in Utah is unique, however, other states have similar efforts. USTAR enlisted the services of SRI International, a nonprofit independent research group, to study USTAR programs and to provide recommendations for proven best practices, programs and metrics that best address the gaps in Utah's technology ecosystem. We look forward to applying these strategic recommendations in the coming year as we continue aligning the organization to the original legislative intent.

Sincerely,

Greg Bell
Governing Authority Chairman
Utah Science Technology and Research Agency

ACCOLADES

The State of Utah has been recognized for its flourishing economy, with a young, well educated workforce, a low unemployment rate and low taxes. According to Entrepreneur.com, venture capitalists invested nearly $1 billion in Utah's startups last year, making it the top state in dollar-per-deal average. These statistics, coupled with Utah's reputation for being a business friendly state, have put Utah on the map for information technology and software developers. Home to heavy hitters like Instructure Canvas, Adobe, Qualtrics, Vivint, Novell, Ancestry.com and the NSA's data storage center, Utah's vibrant technology ecosystem is giving Silicon Valley cause to take notice.

CNBC - Utah is the #3 Top States for Business
24/7 Wall Street – Best State for Business
Nerdwallet – Provo #7 Innovative tech-hub
Wallethub – SLC among best metro areas for STEM professionals
Bloomberg - #13 Most Innovative State
Forbes – # 1 Best State for Business
Ut.gov - #2 lowest unemployment in the nation
Deseretnews.com – U of U ranked top 25 program for entrepreneurs

USTAR's mission to grow the technology ecosystem requires state commitment, collaboration and partnerships with other government entities, non-profits and the private sector (figure 1).

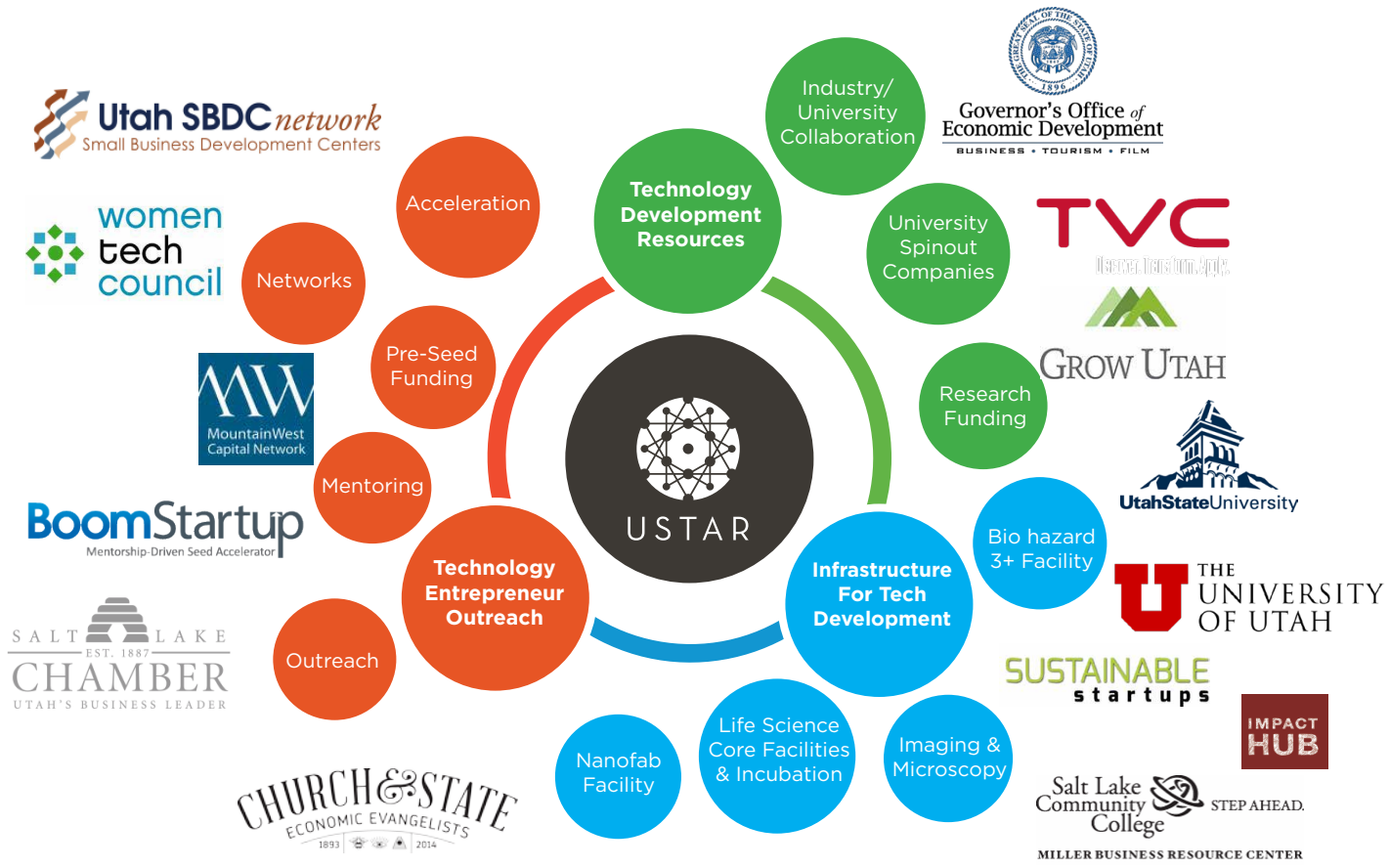


Figure 1.

TECHNOLOGY ECOSYSTEM

An ecosystem is defined as "any system or network of interconnecting and interacting parts, as in a business"* For technology ideas to seed, grow and thrive Utah's technology ecosystem must have robust inventors, a network of technical and business experts, seed capital, research funding and equipment and facilities for ideas to grow, mature and develop.

Utah has a growing network of government leaders, academic, non-profit and private entities working together to build the technology ecosystem for the State. Each part of the ecosystem is necessary for continued economic success in the technology economy of the State.

By connecting new ideas and technologies with entrepreneurs, funding and industry through USTAR's TOIP, the technology ecosystem will continue to thrive. Utah's technology ecosystem is supporting the creation of the next generation of science and tech companies and sustaining technology firms through collaboration, support and a network of resources.

**As defined by Dictionary.com*

YEAR IN REVIEW

This annual report details FY 15 activities of the Utah Science Technology and Research (USTAR) Initiative to comply with statutorily defined reporting requirements (Utah Code 63M-2-401-1). This year is best characterized as a year of significant organizational and cultural change. USTAR's partnerships with the State's research universities have been redefined and reaffirmed through robust collaboration, by clarifying expectations and formalizing policies and processes to assure alignment to the USTAR vision and mission.

Contained within this annual report, readers will find the data and metrics required by USTAR statute 63M-2-401. In addition, the study highlights current USTAR activities, researcher efforts and the background to assist the reader in understanding the USTAR program in the context of the larger Utah technology ecosystem.

USTAR's TOIP continues to adapt to the new governance structure, vision and mission, to assure efficient and transparent support to the technology ecosystem while filing the gaps and not duplicating the efforts of other public and private organizations in the ecosystem. Significant changes to staff and processes at USTAR headquarters (HQ) and within the Governing Authority (GA) have resulted in a focus on development and implementation of policies and procedures required to meet the accountability and transparency standards required of tax payer resources. This pace of change will continue into FY16 as implement the FY13 and FY14 audit recommendations and work with the legislature to consider additional program changes as recommended by our independent assessment (pg. 59).

Major milestones for the USTAR program this year included development and adoption of a unifying vision and mission statement, establishment of budget request process, accounting and fiscal management policies, technical review of the research portfolio, implementation of formal reporting process to track research progress accurately, restructuring of the TOIP program and an independent assessment of Utah's technology ecosystem and the USTAR program. These changes and the recommendations from the independent assessment will bring USTAR into closer alignment with legislative intent.

In November of 2014, the USTAR GA adopted Governor Herbert's vision for *Utah to lead the nation as the best performing economy, and be recognized as a premier global destination* and defined USTAR's mission *to create a technology ecosystem that enables ideas to seed, grow, and thrive*. To accomplish this mission, the USTAR GA has identified three primary objectives (1) Recruit and retain top researchers to the State's research universities (capacity building) (2) Support tech entrepreneurs through training, funding, incubator and accelerator programs (TOIP) and (3) Broker technology transfer by connecting capital, management and industry (TOIP and Industry-University connections).

Since its inception, USTAR has focused approximately 90 percent of it's resources on research capacity development at the state's research universities including the recruitment and retention of faculty and the establishment of state-of-the-art laboratory and core facilities. The focus on capacity building has resulted in more than $31 million dollars of federal funding to Utah's research universities this year alone (see Table 1, pg. 9), and the disclosure of 29 technologies and patenting of three technologies (table 1). There has been a notable increase in Federal funding for Utah's research universities since the inception of USTAR (Figure 2, Note: *this is not a causal relationship*). With more inventions in the pipeline from USTAR researchers and other faculty at the State's universities, USTAR is ready to move into its next phase of supporting technology economic development by introducing new programs that will catalyze the commercialization of these inventions.

To assure we move to the next phase of growing the Utah technology ecosystem efficiently, we commissioned an independent study by SRI International to assess the current Utah technology ecosystem, identify gaps and recommend, based on other states proven best practices, new programs for consideration to most effectively fill these gaps. A summary of the study results can be found on page 59 and the full report at http://www.ustar.org.

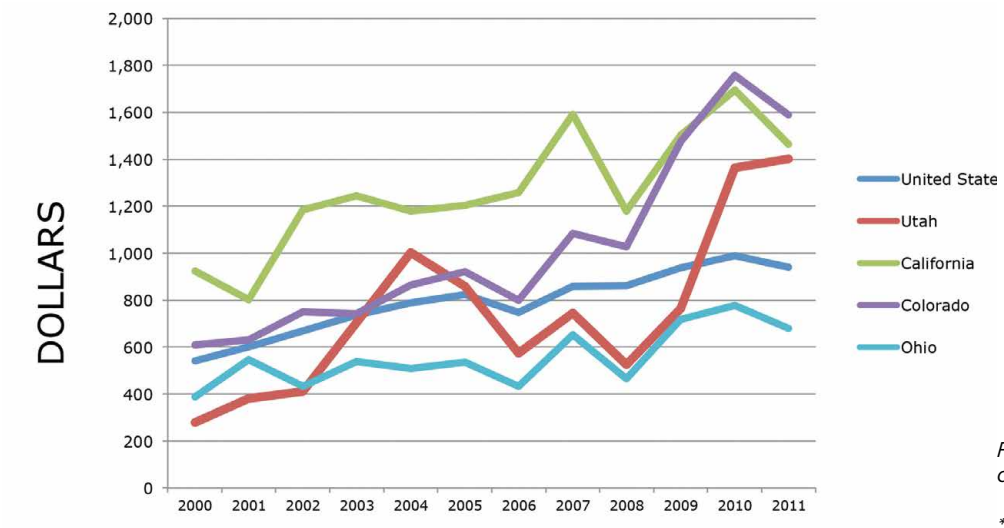


Figure 2. Federal R&D Obligation in dollars per employed worker.

** Source: National Science Foundation*

In summary, the results of the study indicate that USTAR has done well with investment in capacity building, but should shift its investment to later stage technology development and company maturation, assisting in the "valley of death" where federal funding and angel/venture capital are limited. These recommendations will be presented to the legislature for consideration in assuring USTAR funds are used with maximum efficiency.

GOALS, CHALLENGES AND ACHIEVEMENTS

The primary goal of USTAR is to expand economic development by leveraging science and technology investments.

For the first year USTAR measured the impact of its efforts systematically. TOIP was assessed by an independent party to determine the economic impact of the program. These results will provide a benchmark for comparison in future years.

In addition, the SRI study notes the strengths and weaknesses of the Utah technology ecosystem (figure 3, pg. 59). Notably, the research capacity and innovation culture in Utah are strong. However, there are gaps in the ecosystem in the forms of pre-seed and seed funding, venture capital in some domains, industry-university relationships and serial entrepreneurial and management experience.

To address these challenges, a change in USTAR's strategy was needed to increase the competition for USTAR funding, expand from funding early stage research at universities, to include development in

Table 1. Funding and commercialization metrics for university researchers for the current year.*

*Notes: *These numbers are self reported by the universities and USTAR does not have the authority or capacity to validate the numbers. **These patents represent patents filed in all jurisdictions and represents patents on 20 unique technologies. ***USTAR requested expenditures of outside funding, USU was only able to provide the funding received from outside sources in time for this report, therefore this number represents funding received, not expended.*

Institution	Outside Funding	Patent Disclosures	Patents Filed	Patents Issued	Active Licenses
UofU	$23,381,442.84*	21*	35*	0	4*
USU	$8,617,814.77(*)***	8*	35(*)**	3*	14*
Total	$31,999,257.61	29	70	3	18

partnership with industry and to examine the potential for a new ventures program. In order to align USTAR activities to this strategic redirection, USTAR will require changes in statutory authority to include:

1)Eliminating the requirement that all research funding go to Utah's research universities. This will increase the flexibility of entities that can be funded to include the regional universities as well as entrepreneurs. With this change, USTAR will be better able to assure that the best technical approaches with the most potential for impact on the Utah technology economy will be supported.

2)Expanding the role of TOIP to focus on technology clusters in the state, allow for continued development of technology accelerators, incubators and early stage risk funding for start-up companies.

3)Reducing the investment in recruitment and retention of faculty at the research universities. While maintaining the long-term commitments that have been made to recruited faculty, future faculty recruitments must be aligned to an economic development related gap in capacity and should require the university to match funds through an endowed chair model or a salary and startup.

4)USTAR's metrics should be modified to align to these revised strategic directions and include performance metrics, short term metrics and long term metrics, some of which are more effectively captured on a five year basis.

Changes in TOIP this year have addressed many of the challenges in aligning its activities to USTAR's goals and mission, as well as standards in oversight, accountability, transparency and conflicts of interest. TOIP has undergone a strategic evaluation and realignment, and adopted a new mission to: *Create a science and technology ecosystem which will mature and commercialize technology concepts into viable entities.* The specific tasks identified to accomplish this goal include:

- Assisting businesses, applied technology centers, colleges, and universities in building commercial applications for their research
- Connecting market ideas and technologies in new or existing businesses or industries or in regional colleges and universities
- Supporting tech entrepreneurs through training, funding, incubator and accelerator programs
- Brokering technology transfer by connecting capital, management and industry

This new mission statement and the realignment of TOIP activities to support this goal are underway and we anticipate this will improve the TOIP's impact on the State's technology economy. This year we had an independent economic impact study to capture baseline data (pg. 71 and www.ustar.org).

Changes have been made to enhance accountability and transparency in TOIP. The first change was returning all USTAR funded positions to the state payroll, instituting a straight line of reporting to the USTAR executive director. This change was challenging for some USTAR partners at regional universities, but has resulted in TOIP being better aligned to the USTAR mission, the elimination of conflicts of interest for these employees, greater accountability of personnel to the state of Utah and increased transparency in the use of state funds.

For FY15, USTAR HQ focused on implementing policies and practices to provide transparency and accountability in our fiscal systems. These changes will continue into FY16 as we develop a database system that will allow for continuous monitoring of budget and performance metrics.

USTAR has also addressed staffing gaps at HQ and across the organization. These staffing changes included the hiring of a compliance officer and financial staff that will allow for appropriate accounting practices. Additional assistance comes from the attorney general's office and a managing director to focus on the TOIP program. USTAR will continue to develop and formalize policies and procedures in FY16. While we have made significant strides in updating these practices, we still have much work to do to assure we are fully in compliance with both statute and legislative intent. As we move

forward many of the activities that were conducted by the regional universities and partners (human resources, contracting, procurement) will be done through USTAR HQ. This will eliminate many of the accounting and oversight challenges USTAR has faced in the past and will streamline administrative oversight.

The USTAR programs at both research universities have undergone significant changes this year as well. While USTAR HQ is still negotiating agreements, the processes have been put in place to increase the level of accountability and oversight for budget and performance. As discussed previously, both universities were not accounting for USTAR funds with the same rigor as federal or other outside funds. This year required significant work to implement accounting practices that would provide transparency to the GA.

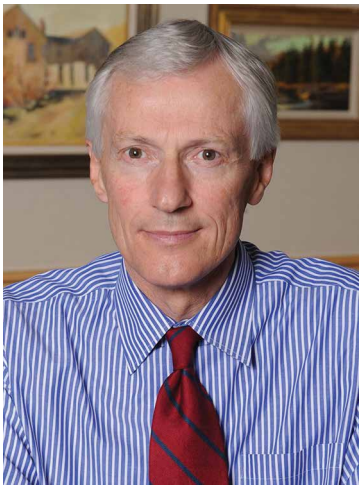
In addition, the GA has implemented a budget process that requires budget requests at the individual researcher or project level rather than the research team in advance of the start of the fiscal year. In addition, these budgets are examined for performance, milestones and commercialization potential in detail by the GA budget sub-committee.

USTAR continues to face challenges in the collecting and validating data required from the research universities to meet the metrics required in USTAR's statute. Specifically, USTAR does not have the authority or the access to the university systems to collect and validate data related to both commercialization expenses, IP license agreements, human resources information and funding information independent of direct funding from USTAR. USTAR can request the information and reference documentation from the universities, but we cannot validate the information.

Additional challenges with the research universities includes the completion of leases for the USTAR building at USU. Despite months of negotiations, USU has not signed a lease per the statutory requirements. Negotiations are ongoing, since at least March, between USTAR and the two research universities to define what constitutes "material support" from USTAR and therefore qualify the IP generated for a return on the revenue to the state.
In the following sections, the reader will get an overview of USTAR activities including descriptions of all projects, researchers and activities.

GREG BELL

GOVERNING AUTHORITY CHAIR



From Lieutenant Governor to USTAR's Chairman of the Governing Authority, Greg Bell works continuously to improve his home state of Utah.

He received his B.A. in political science from Weber State University and J.D. from the University of Utah. He went on to work as head of the commercial real estate and transactions section for Kirton & McConkie, a commercial law firm, until a minor change brought about a big career shift.

While living in Farmington, Utah he was the spokesman for a group that wanted to put a sidewalk in the town. The group liked Bell's leadership, and convinced him to run for city council. A similar pattern followed as he ran for, and served as, mayor of Farmington City, Utah State Senator (2003-2009) and lieutenant governor (2009-2013).

Bell continued to work as a real estate developer in various companies while serving the public, and he is now president of the Utah Hospital Association. He served on the board of directors of Envision Utah from 1998 to 2005, a non-profit organization that helps manage land use and transportation.

"My major accomplishment has been to help Utahns work toward the future and make wise choices about transportation, health care and higher education," said Bell.

Bell's experience and connections in government and business have prepared him to work at the intersection of government and research at USTAR. He has served and represented Utahns for several years, helping pass bills to support issues such as public education and criminal justice, and is motivated by a desire to see Utah succeed.

"I really want to help Utah continue its climb as a state that has a high quality of life with good jobs and adequate tax revenues in order to educate our children and continue to build our state."

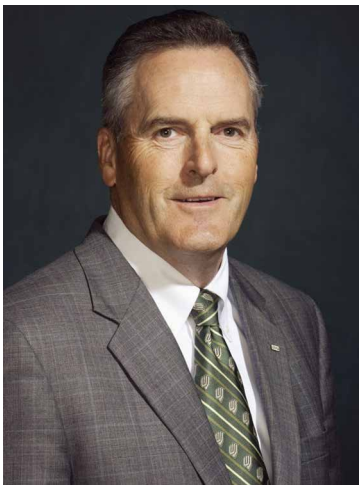
Bell has been with USTAR since January of 2014 and has enjoyed being a part of the developments made in the last year. Stronger relationships with researchers, industry and the legislature have enabled USTAR to meet its goals to create high-paying technology jobs and spin out technology companies. Utah's inventive and entrepreneurial attitude has helped technology flourish in the state, and USTAR plays off of that energy.

"Utahns are early adopters of personal technology," said Bell. "We've had a lot of home-grown companies and we continue to spawn these companies that become really impressive."

As USTAR attracts first-class researchers, they bring in a large sum of research dollars. In turn, they develop cutting edge products which create good companies and high paying jobs. Bell hopes to further improve USTAR by making USTAR finances more transparent to the Utah Legislature and tax payers. He is also working to establish necessary alliances with industry to produce relevant research.

"USTAR is a long-term investment, it's not going to mature into good jobs next year," said Bell. "We have to preach patience, but we've also changed a lot. We're a lot better than we were."

USTAR GOVERNING AUTHORITY



Val Hale, Governing Authority Vice Chair

Before accepting the position as executive director of the Governor's Office of Economic Development, Hale served for two years as president and CEO of the Utah Valley Chamber of Commerce, leading efforts in business community issues— including regional economic development and branding initiatives. Hale was vice president (2010-2012) for university relations at Utah Valley University (UVU), overseeing legislative affairs, marketing and public, media and community relations. From 2006-2010, Hale worked as advancement vice president at the university, responsible for fund raising and all university external activities. During this time, Hale played a key role in transitioning Utah Valley State College into Utah Valley University. Hale started at UVU as the assistant vice president for external affairs (2005-2006), where he served as legislative liaison and oversaw community relations and economic development activities. Hale received his bachelor's degree in public relations in 1981 and a master's degree in communications in 1987—both from BYU. Hale worked as a reporter at the Daily Herald from 1981-1982, covering business, government and BYU.

Richard K. Ellis

Prior to becoming State Treasurer, Ellis served nine years as the chief deputy state treasurer under his predecessor, Ed Alter (a former USTAR GA member). Ellis's other state experience includes three years as the director of the Governor's Office of Planning and Budget under Governors Jon M. Huntsman, Jr. and Olene S. Walker, and a stint as the executive director of the Department of Administrative Services. His career has focused on public finance with experience as the first finance director for Draper City, an investment banker with Dougherty, Dawkins, Strand & Bigelow, and as the assistant treasurer with the Jordan Valley Water Conservancy District. In total, Ellis has more than 24 years of experience in public finance. Ellis received his Master of Business Administration degree from the University of Utah in 1990. He completed his undergraduate work at Brigham Young University where he received a Bachelor of Science degree in business management with a finance emphasis. He currently is an adjunct faculty member of the Marriott School of Business at BYU and teaches a class in cash management and investments for the Romney Institute.

Jennifer Hwu

Jennifer Hwu is president, CEO and co-founder of InnoSys, a Utah microelectronics company that supplies both the USG and commercial sector. She received her M.S. and Ph.D. in electrical engineering from UCLA and was a tenured faculty member and associate chairwoman of the department of electrical and computer engineering at the University of Utah. Hwu previously worked for Walsin Lihwa as deputy CTO and TRW, Electronics and Technology Division as a member of the technical staff. She consults for many companies including MM Wave Technology, E-Systems, Micron Technology and others, and also has a large number of patents. She has received numerous prestigious awards including the US White House Presidential Early Career Awards for Scientists and Engineers (PECASE) and was named a US White House Presidential Faculty Fellow. She has also received many business awards and recognitions including Business Woman Visionary (2004), Best Business Award (2010), Technology Entrepreneur Award (2011), and Women Business Owner of the Year (2013).

USTAR GOVERNING AUTHORITY

Rich Lunsford

Since 2012, Rich Lunsford has been the corporate vice president for health care solutions for Edwards Lifesciences, and previously led the cardiac surgery systems business. Lunsford has more than 30 years experience in the medical device industry, including extensive leadership in global sales and marketing. Before joining Edwards in 2011, Lunsford was president and CEO of Anulex Technologies, a Minnesota-based manufacturer of technologies used during spinal surgery. He has also served as the president and CEO of Acorn Cardiovascular, president of commercial operations at Ev3 and has held leadership positions at Scimed Life Systems/Boston Scientific, Allergan Medical Optics and Spinetech. He received his bachelor's degree in multinational business operations from Florida State University.

Ron Mika

Ron Mika joined Bain Capital in 1989 and was a managing director of the firm from 1996 through the founding of Sorenson Capital in 2003. Mika fulfilled key responsibilities across a variety of investments. These responsibilities incorporated all aspects of executing and harvesting private equity deals including sourcing deals, negotiating documents, structuring, managing and performing due diligence, financing the acquisitions, assisting portfolio businesses in developing market strategies, executing operational improvements and closing add-on acquisitions, board of directors involvement, and exiting investments. Prior to joining Bain Capital, Mika was a top-rated associate consultant/consultant at Bain & Company. Mika received an MBA with honors from the Harvard Business School and a B.S. in chemical engineering, magna cum laude, from Brigham Young University.

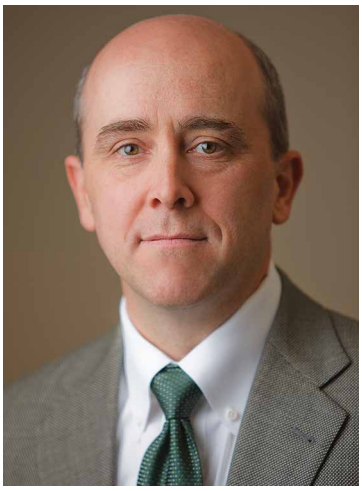
Derek Miller

Derek Miller is the president and CEO of the World Trade Center Utah, an organization dedicated to expanding international business for the State of Utah. Prior to his current position, Miller served as chief of staff to Governor Gary Herbert, overseeing the Governor's Office, the Governor's Cabinet and state operations. He has also served as deputy director of the Governor's Office of Economic Development (GOED) where he was responsible for recruiting new businesses to the state and helping existing Utah businesses to expand. While at GOED, Miller supervised the International Trade and Diplomacy Office and the Rural Development Office. He has also served as director of the Utah Division of Real Estate. Before moving back to his home state of Utah, Miller worked in Washington D.C. for the U.S. House of Representatives as legal counsel and for Arthur Andersen as a management consultant. He is a graduate of the J. Reuben Clark Law School at Brigham Young University, and also holds a Master of Public Administration from the University's Romney Institute of Public Management.

USTAR GOVERNING AUTHORITY

Susan D. Opp

Susan D. Opp is the executive vice president of L-3 Communications, providing a variety of sophisticated communications and encryption products and services for U.S. and foreign military customers. In 1986, Opp began her career as an associate engineer with Sperry Univac and has held positions of increasing responsibility in engineering, product and business development and program management at L-3's CS-West division. Her most recent position was as vice president of strategic development. She earned a Bachelor of Science in electrical engineering from South Dakota School of Mines & Technology, and has a Master of Business Administration from the University of Utah.



Will West

Will West is the CEO of SilverVue, a post-acute care platform that facilitates the transition from traditional fee-for-service healthcare to the new world of accountable care. Prior to founding SilverVue, he was the founder, CEO, and chairman of Control4 (NASDAQ: CTRL). He took the company public after surpassing $100 million in annual revenue. Will retired from Control4 in early 2014 to devote his entire focus to SilverVue. In 1998, he co-founded iBAHN (then called STSN). Under his leadership as the CEO, the company became the worldwide leader in broadband services for business travelers, serving millions of customers in thousands of hotels. Prior to founding iBAHN, Will was CEO and co-founder of PHAST Corporation, a manufacturer of high-end home automation equipment. Like his subsequent companies, PHAST became the leader in its field under his direction. He holds a degree in finance from the University of Utah, and an MBA from the Wharton School at the University of Pennsylvania. He also holds the CFA designation. Will retired last year as the chairman of the board of the Utah Capital Investment Corporation (the State of Utah's "Fund of Funds") where he served for close to 10 years.

USTAR LEADERSHIP

IVY V. ESTABROOKE, PH.D.
EXECUTIVE DIRECTOR

Science and policy may seem like very different subjects, but for Ivy Estabrooke, executive director of USTAR, they go hand in hand.

Estabrooke grew up in rural Maine and became interested in studying the brain when she was misdiagnosed with epilepsy as a teenager. While earning her bachelor's degree in biological sciences from Smith College, she spent two summers working in epilepsy research labs. Upon graduation she joined a sleep disorders lab at the Beth Israel Deaconess Medical Center in Boston, MA.

Estabrooke's interest in neuroscience led her to Georgeotwn University where she completed a doctorate in neuroscience in 2005. While conducting her dissertation research she recognized that she was most interested in the potential applications of the research and best practices for research and higher education than the actual lab work.

"About halfway through my Ph.D. I decided my interests were more aligned to how to apply research and improve outcomes of research. I wasn't going to find a protein or a disease that I could spend the rest of my life working on. So, I started to look at what other opportunities there were to apply my research training."

That other opportunity turned out to be the intersection of science and policy. Estabrooke had been working as a health policy fellow for U.S. Senator Olympia Snowe while finishing her doctorate. She continued doing research as a post-doctoral fellow at Georgetown University, then worked as a science and technology policy fellow for the National Academy of Sciences and later as an AAAS S&T Fellow at the Office of Naval Research in the Department of the Navy.

Working with the military changed her perspective on the importance of applying scientific findings quickly while teaching her to translate science for decision makers who were not trained as scientists. This experience taught her the importance of providing clear data to inform decisions. During her time working for the Department of the Navy, she managed multiple large scale research programs that successfully matured ideas from researchers at universities into tools that could be used by Marines and strategic leaders.

While working at the Office of Naval Research, Estabrooke completed a master's in national security strategy and resource management at the senior joint military school at the National Defense University. The experience exposed her to senior leaders in the federal government, a cohort of US military officers and international officers and formal education in strategy development, acquisition policy and leadership.

When Estabrooke was ready for another challenge the opportunity at USTAR was a perfect fit. In the year Estabrooke has worked for USTAR, she has made many changes. Working with the Governing Authority, she has shifted the focus of USTAR to economic development, more mature technology development, and commercialization.

She has accomplished much in her life, and was awarded the 2013 U.S. Department of the Navy Meritorious Civilian Award and was named to the 2014 Federal 100. Still, her largest contribution is yet to be discovered.

"One of the cool things about science and research is you don't know what your contribution is. Time needs to pass to understand what is going to have the biggest impact. Often it's not the piece that you expect."

USTAR LEADERSHIP

THOM WILLIAMS
MANAGING DIRECTOR

Life can take you places you never expected. A love of technology and traveling has taken Thom Williams, managing director of USTAR, to dozens of countries-from Japan to Afghanistan to Italy. Williams caught the travel bug when he was young; since his father was in the military, he regularly moved every few years all around the world and the U.S.

"I was really interested in aviation and all things technology," he said. "I knew I wanted to be around aircraft, aviation, or engineering."

He received his B.S. in aeronautics from San Jose State University and joined the Marine Corps as an air-command and control officer where he was trained as an air traffic controller as well as how to shoot aircraft down as an air defense officer. He received his Master of Economics from the University of Oklahoma in 1998.

Williams worked in the Pacific traveling to perform exercises and training events with allied and foreign militaries. He was then stationed in Italy at the NATO headquarters and worked throughout Europe, former Soviet Union countries and the Middle East.

"Every job and every contact teaches you something," he said. "I'm a lucky man in terms of the depth of experiences I've had, places I've gone, people that I've met and governments that I've engaged with."

Williams career took a much desired turn between 2001-2010 as he began to influence research at the Missile Defense Agency. Later he became involved with advanced technology programs of the Marine Corps and the Navy Seals working at the Office of Naval Research. There he oversaw more than 500 programs and managed program managers for logistics, weapons, vehicles and more.

"One of the greatest things I have accomplished is giving Sailors and Marines the tools they needed to succeed and survive in a combat environment," he said.

After developing and advancing these technologies he was given the opportunity to use them in a combat environment. In 2011 he was deployed to work in Afghanistan as the director of the Joint Border Coordination Center and partnering with Afghan and Pakistani military to enhance cross-border coordination and oversee operations along the highly sensitive Afghanistan-Pakistan-Iranian Border. During that same period, Williams led a team of mentors to train 5,000 Afghan border police, as well as Afghans in aviation and security operations at the Kandahar International Airport.

Williams retired and moved to Colorado in 2014, where he worked as a military consultant and an advisor for Apple until one call brought him to Utah. His experience in various jobs and with a broad range of research helped prepare him for his role now at USTAR.

"I want to build a strategic plan that allows USTAR to achieve its goal," he said.

For him, that goal of stimulating the economy and creating higher-paying jobs is a worthwhile one. He is proud and excited to be a part of a team that will move the economy forward.

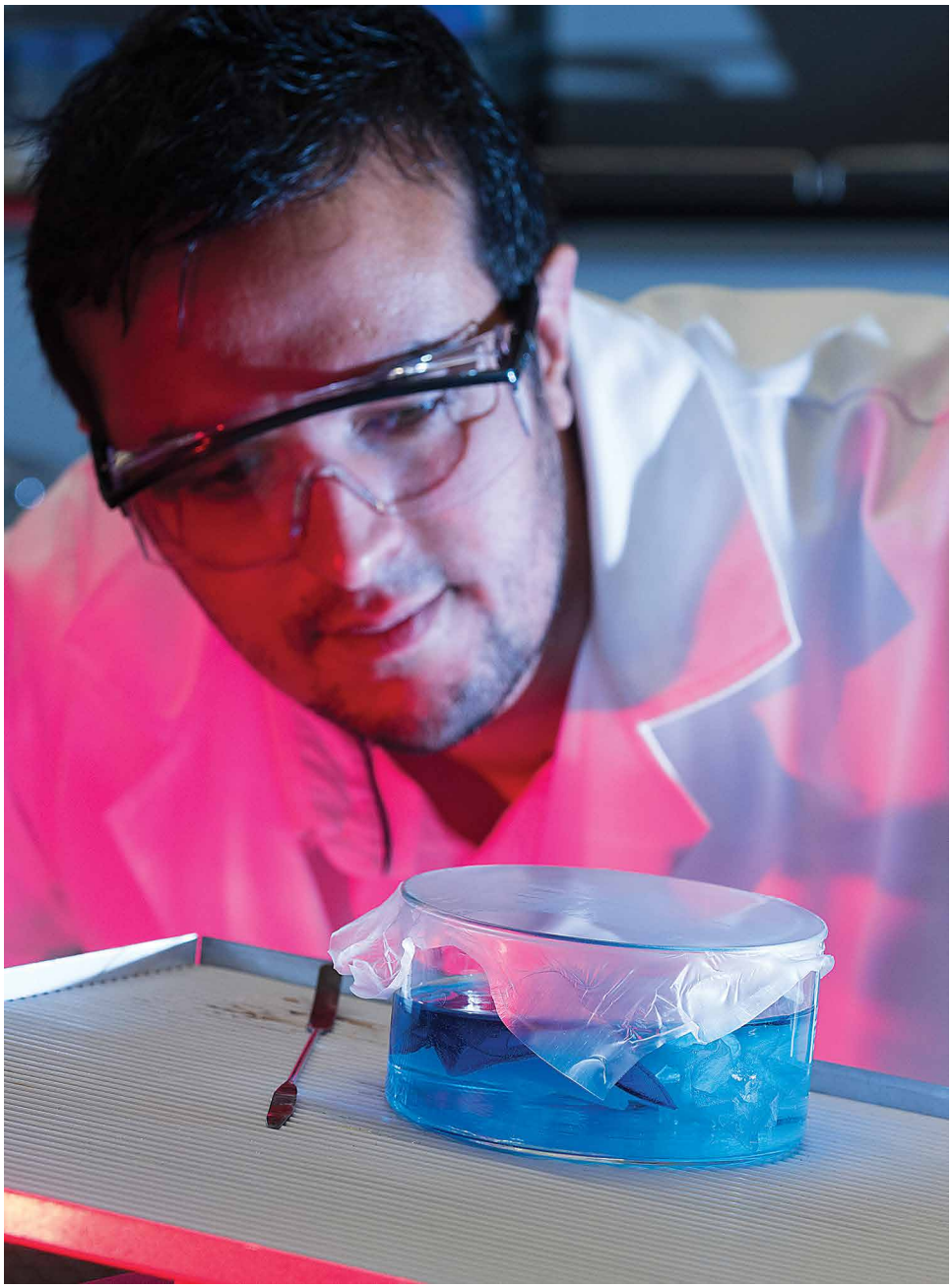
SEED

BUILDING RESEARCH CAPACITY

USTAR researchers contribute ideas and technology that over time will result in business growth, higher paying jobs, an expanded tax base and a healthy economic future for the state of Utah. The quality of faculty increases educational opportunities and attracts other high-caliber faculty and competent graduate students to the state. The researchers recruited and funded by USTAR align to important industry clusters in the state in the areas of Energy, Life Sciences, Micro/Nano Systems and Big Data.

ENERGY

The energy sector in Utah is diverse and robust. USTAR professors at USU and the U of U are researching new technologies that will equip the State and the nation to conserve the natural resources we have and provide alternatives to traditional petroleum, from optimizing biological processes for energy recovery, biological materials for gasoline, geothermal energy recovery and wirelessly charged electric vehicles. The diversity of ideas and disciplines engaged in novel approaches to energy will lead to a diversified economy and address both energy and environmental needs for the future of the State.



USTAR FACULTY

Foster Agblevor, Ph.D. ***Utah State University***

Foster Agblevor is a USTAR professor of biological engineering at USU and director of the USTAR Bioenergy Center. Prior to joining USU in 2011, Agblevor was a professor of biological systems engineering at Virginia Tech. He has developed pyrolysis methods to make bio-crude oil, which can be refined into gasoline from plant materials. Agblevor has also developed a pyrolysis processes to remove phosphorous from chicken litter – a mix of manure, wood chips and feathers that is a by-product of chicken farming. Agblevor's self-sustaining process transforms chicken litter into three products: a gas that provides fuel to power the pyrolysis reactor, bio-crude oil that can be refined into fuel or made into plastic. Agblevor received a Fulbright grant to research ways to convert grass into bio-crude oil for manufacturing plastics.

Seth Lyman, Ph.D. ***Utah State University***

Seth Lyman, executive director of the Bingham Entrepreneurship & Energy Research Center at USU, is an expert in air quality measurements and instrumentation. He received his B.S. in conservation biology from Brigham Young University in 2004 and Ph.D. in environmental science from the University of Nevada, Reno in 2009. His current research addresses the challenges of wintertime ozone production in the Uintah Basin, energy source emission characterization and atmospheric instrument innovation and development. In June 2014, Lyman testified before the House Natural Resources Subcommittee on Energy and Mineral Resources regarding how America's educational institutions are creating a skilled and educated workforce crucial to the continued growth of the energy sector.

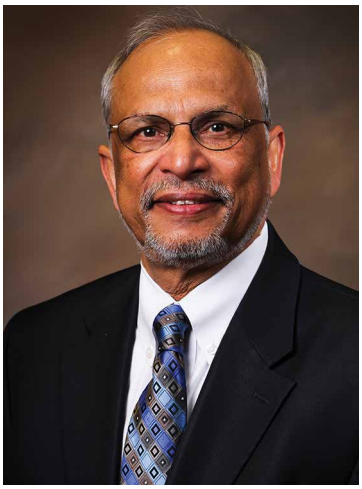
John McLennan, Ph.D. ***University of Utah***

John McLennan is a USTAR associate professor of chemical engineering and adjunct professor of civil and environmental engineering at the U of U. McLennan attended the University of Toronto for his B.A.Sc. in geological engineering (1974), M.A.Sc. in civil engineering, soil mechanics (1976) and Ph.D. in civil engineering, rock mechanics (1980). He served on the Society of Petroleum Engineers Committee in 2011 and was awarded the Rocky Mountain North America Regional Service Award in 2012. McLennan's recent work focuses on optimized gas production from shale and unconsolidated formations, fluid-rock interactions, geothermal energy recovery, in-situ microbial generation of natural gas and sustainable use of earth energy resources. His research interests also include improving geothermal energy extraction and increasing rate and recovery of natural gas.

USTAR FACULTY

Brian McPherson, Ph.D. *University of Utah*

Brian McPherson joined the University of Utah as a USTAR professor of civil and environmental engineering from the New Mexico Institute of Mining and Technology. There, he formed the Southwest Partnership on Carbon Sequestration in 2003, one of seven regional partnerships funded by the U.S. Department of Energy to evaluate the science and technology of storage of atmospheric carbon in underground geological formations and surface soil and vegetation. McPherson's research focuses on groundwater hydrology, petroleum and energy resources engineering, numerical modeling of groundwater flow and coupled practices and rock mechanics measurements and modeling. The Department of Energy's National Energy Technology Laboratory (NETL) has provided ongoing funding to begin a deployment phase, which includes injecting 1,000,000 tons of CO2 into a geological formation and evaluating the approach for reduction of greenhouse gases in the atmosphere.



Manoranjan Misra, Ph.D. *University of Utah*

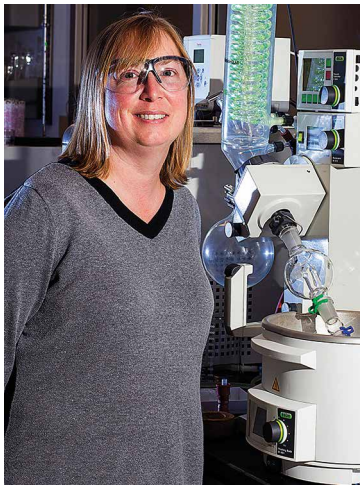
Manoranjan Misra is Chair of metallurgical engineering and USTAR professor of chemical and mechanical engineering at the U of U. He is also director of the Roger and Dawn Crus Center for Renewable Energy, established in 2014. He received his B.Sc. in chemistry from Utkal University in India, and then went on to receive a M.Sc. in chemistry from Regional Engineering College and a M.S. in metallurgical engineering from South Dakota School of Mines and completed his Ph.D at the U of U. He has published two books and more than 200 technical papers and holds 28 patents. Misra has worked for 30 years in the field of energy and materials development, focusing on photoelectrochemical hydrogen generation, radiation detection and nuclear materials and arsenic removal. He is also working on the conversion of waste materials to fuel and the development of rapid portable sensors for biomedical diagnostics and radiation detection.

Caroline Saouma, Ph.D. *University of Utah*

Caroline Saouma is a USTAR assistant professor in the Department of Chemistry at the U of U whose research is focused on synthetic inorganic chemistry for catalysis, energy, and health. Applications of her work may lead to clean energy fuel cell and CO2 reduction technologies. Currently, Saouma's team is working on activation of O2, electrocatalytic CO2 fixation, and CO2 reduction to methanol, and is developing catalysts for the reduction of carbon dioxide by using techniques that will ultimately recycle carbon dioxide back into fuels. After receiving her B.S. in chemistry at MIT in 2005, she moved to Pasadena to pursue a Ph.D. at Caltech, where she was an NSF graduate fellow, and her dissertation focused on iron mediated reduction of CO2 and N2. She then went to the University of Washington as an NIH postdoc fellow (2011-2013) and worked on proton-coupled electron transfer reactions of metal clusters. She was awarded the ACS DIC Young Investigator Award in 2012, and began her career at the U of U in January 2014.

SHELLEY MINTEER, PH.D.

UNIVERSITY OF UTAH



Ever used sugar to power a computer? Shelley Minteer, USTAR professor of chemistry and materials science and engineering at the U of U, is studying how chemical reactions in nature, like metabolizing table sugar, can fuel the future. Minteer leads the USTAR Alternative Energy Cluster at the U of U and studies bio-inspired energy conversion as an alternative energy source.

She pursued her bachelor's degree in chemistry at Western Illinois University and completed her Ph.D. in chemistry in 2000 at University of Iowa. She later joined Saint Louis University Department of Chemistry as faculty member for 11 years.

Minteer and her research group create bio-batteries that work twice as long as lithium batteries found inside cell phones and computers. The ultimate goal is to have bio-batteries be 10 or 20 times as energy dense as current metal batteries.

Similar research is taking place around the globe, but Minteer's lab uses genetic engineering to make batteries more efficient. This is made possible by USTAR, who provides the infrastructure and instrumentation to make Minteer's research possible. She came to the University of Utah because of USTAR's equipment and emphasis on bringing research out of the labs and to the public.

Minteer recently received a five-year grant from the Army Research Office to continue her alternative energy work in hopes of finding more efficient and lighter batteries for soldiers. Lighter batteries could remove up to 30 pounds from the soldiers' packs and improve their quality of life. While the rest of society might not notice a lighter cell phone, they would notice a battery they don't have to charge every other day. As cell phones and tablets become more complex and are expected to complete more tasks, batteries will need to evolve with them.

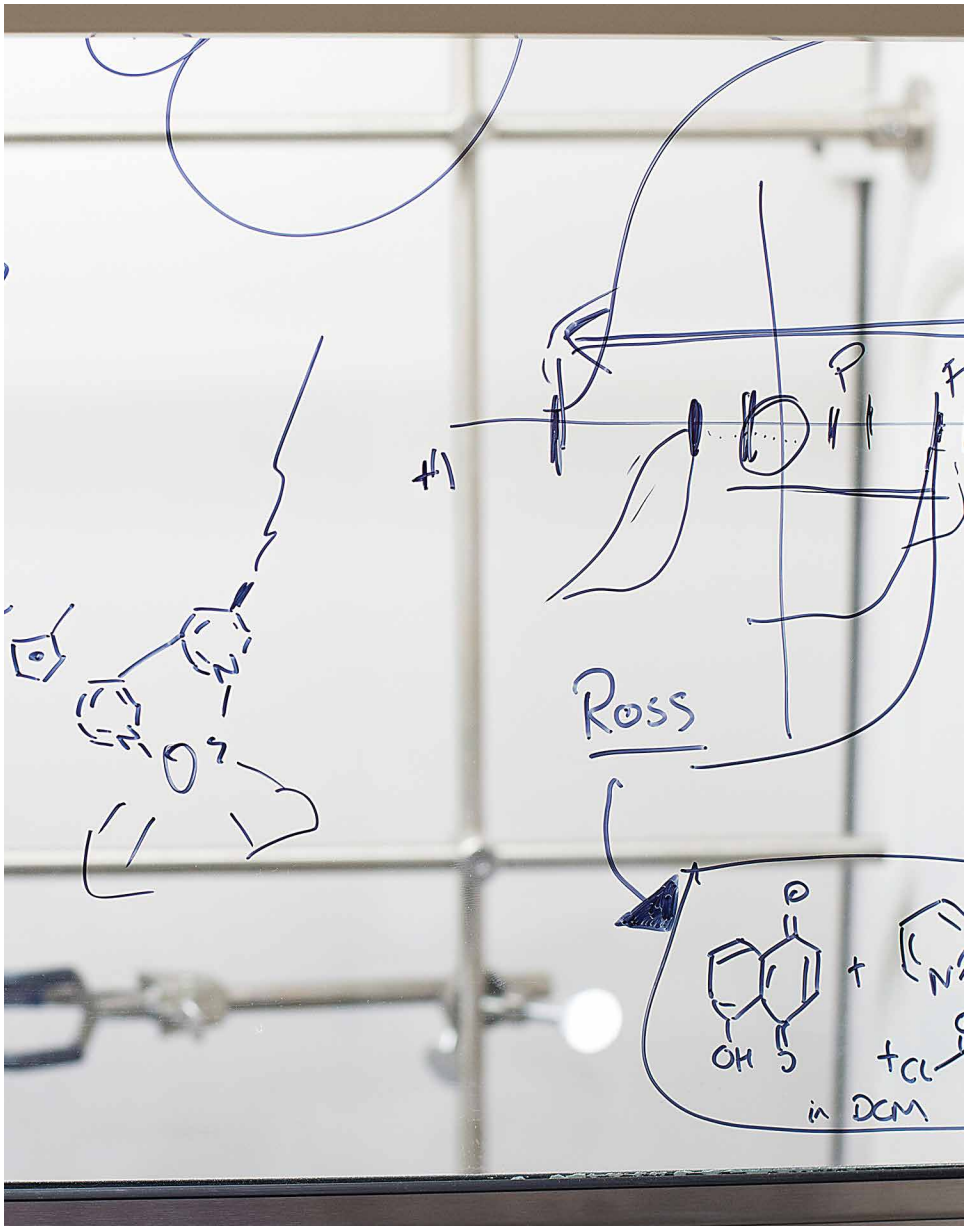
At the NSF-funded Materials Research, Science and Engineering Center (MRSEC) at the U of U, with matching funds from USTAR to fund equipment in the Nanofab, Minteer has been collaborating with other researchers and graduate students in the area of bio-solar cells and plasmonic enhanced fuel cells. In another NSF-funded project, she is creating bio-batteries built into contact lenses fueled by chemical components in tears.

Minteer believes in innovation because commercializing science is a big part of being a scientist. It is critical for scientists to make something practical from their research to continue improving society. Every scientist is working to solve a problem.

"You don't want to do science just for the sake of science. You want to do science to make mankind better, and everyone has a different view of how to do that," she said.

LIFE SCIENCES

The life sciences cluster in Utah is notable for the breadth of work and historic successes. The U of U has an outstanding Health Sciences system combining state of the art care and an extensive research network that has produced economic drivers ARUP, Myriad Genetics and BioFire, to name a few. USU, a land grant institution, is a leader in agriculture and veterinary sciences. The life science industry is capital intensive, highly regulated and requires a long development timeline. In order to be competitive in this domain, Utah will need to continue to support our researchers in the life science community, address the challenges of regulation and address the risk capital that is needed to develop companies in Utah.



DANNY CHOU, PH.D.

UNIVERSITY OF UTAH

Danny Chou, USTAR assistant professor of biochemistry at the U of U, did not have plans of entering the biology field as an undergraduate. He was a "pure chemist," as he described himself, until he realized biology and medicine use a chemical approach to solve problems. Now, he is trying to solve one of the biggest medical problems of this time, Diabetes.

For those with diabetes, constantly pricking fingertips to test blood glucose levels is a minor struggle when compared to the side effects of too much or too little glucose, which can cause a coma or death. It is a lifelong struggle that can be improved by Chou's smart insulin, named Ins-PBA-F. This insulin actively regulates blood sugar throughout the day by monitoring levels and releasing a drug when blood sugar levels are high. Instead of injecting insulin throughout the day, diabetes patients would only need to inject this smart insulin once each day.

This new technology would benefit Type 1 and late-stage Type 2 diabetes patients. In Type 1 diabetes, the individual's pancreas produces little or no insulin. Type 2 diabetes patients do not sense insulin well, and in its late stages resemble Type 1 diabetes. In a normal healthy human pancreas, alpha and beta cells in the pancreas work together to secrete insulin and glucagon. "They counteract each other in a way to make the blood sugar always be the right level," said Chou. "In Type 1 diabetes patients, this kind of function is impaired."

While similar research is taking place around the globe, Chou's research is unique because of its chemical approach as opposed to the typical biological one. Chou is using his background in chemistry to synthesize insulin.

Chou completed his B.S. in chemistry at National Taiwan University and then went to Harvard University for his Ph.D. While working on his Ph.D., Chou began studying the survival of pancreatic beta cells, insulin-making cells found in the pancreas. He continued working on insulin as a post-doctoral fellow at the Massachusetts Institute of Technology. He worked there until the offer came from the University of Utah and USTAR to bring his research here. "The opportunity USTAR offered was a big part of my decision to come to the University of Utah," Chou said.

The applied research USTAR encourages was a perfect fit for Chou to continue his research and one day bring a product to the public. While still in the basic research phase, Chou looks forward to helping the estimated 371 million people worldwide who suffer from diabetes. In three to five years, Chou will begin the next step and perform clinical trials. His ultimate goal is to get smart insulin on the market, and he is already partnering with local biotechnology companies to plan production.

Chou is also making components that could be used in an artificial pancreas. Like the pumps many diabetes patients wear, the pancreas would sit outside the body but have two pumps instead of one. There would be a pump for insulin and glucagon with computer algorithms controlling secretion of each hormone. As more and more people are diagnosed with diabetes each year, including some of Chou's family members, Chou believes now is the time to find a solution to this chronic condition.

"It's a very big problem throughout this country and a big worldwide epidemic," he said. "We are developing therapeutics that could help treat diabetic patients and help them with their quality of life."

Chou has only been at USTAR for one year, but already his research is rapidly producing results that could change the future of millions worldwide.

ALAN "CHUCK" DORVAL, PH.D.

UNIVERSITY OF UTAH

As medicine improves, doctors have the ability to prolong life. Still, some diseases may destroy our brains and nervous systems while our bodies remain in top-notch shape. Alan "Chuck" Dorval, USTAR assistant professor of bioengineering at the U of U, is studying how to fight off and cure these neurological diseases.

Dorval's research concentrates on a new, effective therapy for neurological disorders known as deep brain stimulation. An electrode is placed deep into the brain during surgery and electrical signals are sent to stimulate target nuclei through quick shocks.

"It paces that region of the brain just like a pace-maker paces the heart, except instead of going about once a second like the heart does, it paces it at one to two hundred times a second," said Dorval.

These stimulators have been successfully implanted in more than 100,000 patients with Parkinson's disease or Essential Tremor. While proven to work, there is little understanding of why these electrical shocks stop tremors. Dorval's research aims to better understand how deep brain stimulation changes the information processing of the surrounding nervous tissue. That success could soon be applied to patients with other neurological disorders, such as obsessive-compulsive disorder and Autism.

In Dorval's lab, his team is shrinking deep brain stimulators down to the microscopic level. Current technology has a stimulating contact of six square millimeters with four contacts on each electrode. Dorval's electrodes have about 2,000 with each contacting 1/100th of a square millimeter. "They are on the scale of individual neurons so we can pattern and change individual neuronal activity, something no one else is doing," he said.

Dorval's understanding of electrodes comes from his background in electrical engineering. While studying at Rensselaer Polytechnic Institute in New York, he grew bored designing circuits and discovered that the human nervous system worked in a similar way, but with a complexity that compelled him. He switched his focus to biomedical engineering and in a senior research project came in contact with Functional Magnetic Resonance Imaging (fMRI). fMRI is a non-invasive technique that uses changes in blood oxygenation levels to understand the activity of the brain during specific cognitive activities.

Dorval came to the U of U in 2009 because of its world-renowned neuro-engineering department and USTAR's emphasis on commercializing research. USTAR helped push Dorval toward technology development and with support, he was able to get funding for patent development on his tiny deep brain stimulator electrodes.

Neurological disorders plague the lives of many people around the world. They impair your perception of the world and alter the way you interact with it. Dorval is collaborating with researchers all over the country to help repair lost nervous system functions of the countless people who suffer.

"Ultimately we all die but before death, what I'd like to do is help as many people as possible experience the world as richly as possible for whatever time they have."

USTAR FACULTY

Liaohai Chen, Ph.D. *Utah State University*

Liaohai Chen is a professor in the Department of Chemistry and Biochemistry at USU. His lab is currently conducting research projects aimed at disease diagnosis, molecular imaging, new biomaterials, mitochondria intervention and developing artificial mitochondria. Chen's projects include developing a breath test for cancer, a drug delivery system based on mitochondrial sub-particles, and visualization assays for disease diagnosis. Chen received his PhD in organic chemistry from University of Rochester in 1997. He joined the Biosciences Division at Argonne National Laboratory in Illinois in 2001, where he was a group leader and molecular biologist. While in Illinois, he was also an Associate Professor in the Gyn-Oncology section at Rush University Medical Center.

Hamid Ghandehari, Ph.D. *University of Utah*

Hamid Ghandehari is an expert in drug delivery innovation and a professor of pharmaceutics, pharmaceutical chemistry and bioengineering at the U of U. He directs the Utah Center for Nanomedicine and is a co-founder and co-director of the Nano Institute of Utah. He is the chief scientific officer for TheraTarget, a University of Utah USTAR spinout company that specializes in synthesizing molecular drug delivery systems. Research at Gandehari's lab focuses on four main projects: 1) the design of genetically engineered polymers for gene therapy of head and neck cancer, 2) water-soluble polymers for delivery of angiogenic inhibitors to solid tumors, 3) polymeric carriers for oral delivery of chemotherapeutics, and 4) assessing the biocompatibility of inorganic nanoconstructs with the potential for targeted drug delivery. Ghandehari has a B.S. in pharmacy and a Ph.D. in pharmaceutics and pharmaceutical chemistry from the University of Utah.

Julie Korenberg, Ph.D. *University of Utah*

Julie Korenberg is a USTAR professor of pediatrics and director of the Center for Integrated Neuroscience and Human Behavior at the U of U. She came to the U of U in 2008 and has since founded the Down Syndrome Therapeutic Consortium and the Williams Syndrome Program. Her current research focuses on Williams syndrome, a genetic mutation that causes serious physical and behavioral deficiencies. With magnetic resonance imaging (MRI), Korenberg is decoding the genes to better understand the biological pathways of hyper-social behavior. Korenberg is a founder of the Department of Human Genetics, UCLA and established the Neurofibromatosis Clinic and Programs for Down syndrome and Williams syndrome at Cedars-Sinai Health System. She received her B.Sc. from McGill University in Montreal, Quebec and her M.S. in medical genetics from the University of Wisconsin, Madison. She then attended the University of Miami School of Medicine and obtained a joint Ph.D.-M.D. degree.

USTAR FACULTY

Young Min Lee, Ph.D. *Utah State University*

Young-Min Lee is an assistant professor of animal, dairy and veterinary sciences and directs a molecular virology laboratory at USU. His research group is at the forefront of viral research for JEV and PRRSV, both economically important viral pig diseases. Using infectious cDNA technology, Lee's research aims to answer questions about the viral life cycle, discovering novel targets for antiviral therapeutics and vaccines. He received his first B.S. degree in biology from Chung-Ang University (Korea) in 1991, and his second B.S. degree in biological sciences from the University of Minnesota in 1993. He completed his Ph.D. in 1998 at Johns Hopkins University and then conducted post-doctoral research at Washington University.

Aaron Quinlan, Ph.D. *University of Utah*

Aaron Quinlan joined the USTAR Center for Genetic Discovery as associate director in 2015 and is currently associate professor of human genetics and biomedical informatics at the U of U. He received his B.S. in computer science from the College of William and Mary, Virginia in 1997 and his Ph.D. in biology from Boston College in 2008. He served as session Chair for the American Society of Human Genetics Meeting in 2014 and was a finalist for the Gordon and Betty Moore Data Driven Discovery Competition in 2014. He is an expert in computational genomics and data integration tools. Quinlan has developed several popular software packages for large-scale genome analyses and human disease studies. By combining genetics and genomics techniques with computer science and machine learning, his research group is developing new ways to understand genome biology and the genetic basis of traits. The group strives to develop improved software to interpret human genomes and advance clinical treatment of human diseases.

Perry Renshaw, Ph.D. *University of Utah*

Perry Renshaw's work at the U of U's Brain Institute has led to clinical trials for treatments for methamphetamine addiction, depression and bipolar disorder, including natural substances as possible treatments. Current clinical trials are focused on the use of citicoline as a treatment for methamphetamine dependence, creatine as a treatment for depression, and uridine as a treatment for bipolar disorder. Renshaw's recent work focuses on brain chemistry changes that may increase depression and suicide for people living at high altitudes. Another of Dr. Perry's recent studies showed that methamphetamines damage adolescent brains more than adult brains. Renshaw has 12 patents and has 17 patents pending. He received his M.D. and Ph.D. (biophysics) degrees from the University of Pennsylvania School of Medicine before completing his residency in psychiatry at the Massachusetts General Hospital in 1992.

RANDY LEWIS, PH.D.

UTAH STATE UNIVERSITY

What's stronger than Kevlar, more elastic than nylon, and can be extracted from goat's milk? No, this is not the start of a bad joke. It is the research of Randy Lewis, USTAR professor of biology at USU, who is creating new materials and applications for synthetic proteins that mimic the genetic code of spider silk.

Lewis began his science career as an undergraduate chemistry student at CalTech. He received his master's degree and doctorate in chemistry/biochemistry from University of California, San Diego and discovered a new role for proteins secreted with adrenaline in severe stress-induced situations during his post-doctoral fellowship at the Roche Institute of Molecular Biology in New Jersey. In 1990, he cloned the spider silk gene, a feat he considers to be the highlight of his career.

"When we started that, no one had the slightest idea what these proteins looked like. If you take a look at where the field is at right now, a very large percentage of what people are doing is based on that early research we did in cloning the first spider silk genes."

Lewis collaborates with experts at different universities in the physical analysis of proteins, adhesive properties of spider silk and fabric assembly. His current efforts focus on characterizing and replicating the many types of silk produced by spiders. Each silk has very different mechanical properties that can be applied to a variety of applications.

With advances in genomics and sequencing technology, Lewis was able to sequence the code for the spider silk protein and transfect it into other organisms that can produce the proteins in large volumes, such as silkworms, bacteria and goats. When goats secrete it in their milk, the protein is purified, freeze-dried into a powder and re-dissolved into a water solution. From there, the protein is either spun into fibers or used to coat various objects. The fibers made from silkworms use a composite of spider silk and their own silk proteins. In bacteria, the silk is produced in large volumes and then purified from the bacterial growth medium.

The spider silk coatings can include anti-bacterial or anti-clotting agents for coating catheters to decrease infection. It could be made into a gel to coat cells for tissue repair or regeneration in the body. The fibers could be used for sutures, artificial ligaments and tendons as well as for reinforcing fibers for car body panels, bicycle tires or sails on sailboats. Lewis's spider silk has been used in prototypes for three companies already, and companies contact him on a regular basis asking to apply this new technology to their product. "We're solving a number of problems," Lewis said. "We are providing material that functions in places where there is no material that can do that."

Silicon catheters, for example, cannot currently be coated by anything. This leads to significant infections in patients. Being able to coat them with an antibacterial compound could decrease infection rates and reduce medical costs. Lewis and his team hope to create new products and make current ones better, something spider silk proteins can do for a broad range of items. In order to connect with companies from various fields and develop relationships, Lewis needed the commercialization support that USTAR offers.

Lewis anticipates products on the market soon containing the spider silk material. He plans on working on spider silk until the day he retires, but he sees endless possibilities for growth in the rising generation of students.

GABOR MARTH, PH.D.

UNIVERSITY OF UTAH

Gabor Marth of the USTAR Center for Genetic Discovery, along with his co-researchers, is developing new insights into cancer, infectious diseases, genetic diseases and other medical mysteries by speeding up and simplifying the analysis of genomic data and by bringing genomics to life through data visualization.

The goal of the Center for Genetic Discovery is to bring analytical computational power to jump-start precision medicine not only for ourselves, but for a number of collaborators in the medical school and in other parts of the university. One of Marth's major contributions to this effort is IOBIO, a real-time, interactive web interface for analyzing genetic data that enables clinicians, physicians and researchers to see that data in ways they have never been able to before.

"Genomic big data is large – terabytes upon terabytes of data," Marth said.

Multiply that by millions of individuals in large public genetic databases, or even by five or six biopsy samples from a single cancer patient during the course of treatment, and you might have a data set that takes days or weeks to analyze using old-fashioned server farm methods. To further complicate analysis, the data is often represented as hard-to-read command-line data dumps, or giant spreadsheets. The IOBIO system uses only relevant "slices" of genetic data to look for meaningful information that can be rendered as a variety of colorful, easy-to-read charts and graphs. The data set can be analyzed in real-time from multiple perspectives, generating insights that would previously have required weeks or months of combing through tables.

The "engine" behind a recently developed IOBIO web tool is Taxonomer, a genetic analysis software system developed by Mark Yandell, Marth's colleague and collaborator. IOBIO is the web interface and data visualization system for Taxonomer. Simple IOBIO tools are being added to huge collaborative genetic research projects such as Galaxy and public genome databases like the National Center for Biotechnology Information. The IOBIO system has a variety of applications, but three of the most important are diagnosing infectious disease, identifying genetic disease and pinpointing effective cancer treatment.

In diagnosing infectious disease, IOBIO will enable clinicians to look for microbes in a sample taken from a patient who might have ambiguous symptoms. For example, if a parent brings a child with a cough to a pediatrician's office, the physician might want to do a genetic analysis of a mucus sample to find out if the child has strep, pneumonia, RSV, flu or a common cold. The IOBIO system can replace slower, less comprehensive tests such as sending samples to a lab for culture. The physician doesn't have to make a hypothetical diagnosis before ordering the test, and then wait for hours or days to find out if the diagnosis is correct.

In the case of genetic disease, a patient's genome can be compared with known disease-causing variants. If the patient's doctor finds a match, the diagnosis may be simple. If there is no match, IOBIO enables researchers to look for related variations, for example a variation on the same gene that has a similar effect on proteins. The patient's genetic data can also be compared to their parents' data to determine inheritance patterns. All this information is rendered in simple graphic form.

As he has worked to ready IOBIO and other research projects for commercial applications, Marth has appreciated the support and insight he has received from USTAR. "I think it's great that the state of Utah is supporting not just research, but also its commercialization," he said.

IRINA POLEJAEVA, PH.D.

UTAH STATE UNIVERSITY

Irina Polejaeva has enjoyed working with animals from a young age. When visiting her grandma in the countryside of Russia, she would play with the chickens, cattle and other farm animals. After high school, she went directly into a master's program in animal science at the Kubanski Agricultural University.

"I had an interest in animal genetics and developmental biology, which studies animal growth and development, including early embryonic life," said Polejaeva. "The early embryonic events play a profound role not only during fetal development, but could affect animal health and production throughout their lives. I found this field of research to be very intriguing."

With her focus shifted to embryology and stem cell biology, Polejaeva pursued a doctorate in developmental/stem cell biology at the National Institute of Animal Science in Moscow, Russia. She came to USU as a postdoctoral fellow and worked with Ken White on bovine (cow) and mink embryonic stem cells. She took her knowledge to the private sector, working as both head of the Cell Biology Group and project manager for the Porcine Nuclear Transfer Program for PPL Therapeutics Inc., a British biopharmaceutical company made famous for cloning Dolly the sheep in collaboration with the Roslin Institute.

There, her work led to her biggest technical accomplishment, developing somatic cell nuclear transfer (SCNT), a technique that creates a clone animal from a donor nucleus. This work led to the generation of the world's first cloned pigs by SCNT and the birth of the world's first 1, 3-galactosyltransferase deficient pigs.

She returned to Utah State University in 2011 after learning about a faculty position opportunity with USTAR. As associate professor in the Animal, Dairy and Veterinary Sciences Department, Polejaeva is working on improving cloning efficiency through understanding molecular mechanisms behind cloning. In collaboration with cardiologists from University of Utah and Intermountain Heart Institute, she is studying the role of cardiac fibrosis in cardiovascular disease using goats as models. Cardiac fibrosis is the formation of excess fibrous connective tissue in the heart, which is associated with a variety of cardiac diseases.

Polejaeva's laboratory is also combining SCNT and emerging genome-editing technology to show that beneficial livestock traits can be transferred between species. Some animals, like sheep, have a much higher muscle, and therefore meat production due to naturally occurring mutations. Genome editing tools allow Polejaeva to experiment with the naturally occurring mutations from the sheep and introduce the new sequence in goats. A goat that has a higher muscle/meat density has potential to be a more efficient animal in countries where meat is scarce and goats are easier to maintain than sheep, such as in Africa and Southeast Asia.

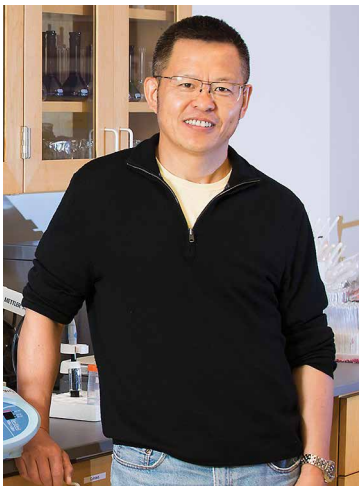
Polejaeva was recently selected as the recipient of the 2015 Faculty Researcher of the Year Award from her department at Utah State University. She is an active member of the American Heart Association and the International Embryo Transfer Society (IETS) and was recently elected to the IETS Board of Governors. Since joining Utah State University four years ago, Polejaeva has established an extensive collaborative network with local, national and international organizations.

"Collaborative efforts will allow us to accelerate progress in our field. I hope the outcomes of our research will be beneficial for not only the state of Utah but, in general, human health and society."

USTAR FACULTY

Matt Wachowiak, Ph.D. *University of Utah*

Matt Wachowiak is an associate professor of neurobiology and anatomy at the U of U. Wachowiak's research focuses on sensory encoding and brain processing of olfactory information. Researchers in Wachoviak's lab use optical imaging to visualize neural activity in real time in the intact brain. A goal of this work is to understand how active behaviors such as sniffing and touching shape sensory processing in the brain. Potential commercial applications of his work include the development of "artificial nose" sensors to detect explosives, drugs or other substances. Wachowiak received his B.S. from Duke University and his Ph.D. from the University of Florida in neuroscience. He was a postdoctoral fellow at Yale University School of Medicine in the department of molecular and cellular physiology. He was a faculty member at Boston University for eight years before joining the USTAR faculty at University of Utah in 2010.



Zhongde Wang, Ph.D. *Utah State University*

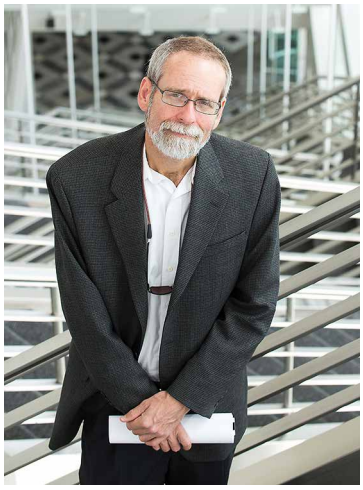
Zhongde Wang is currently an associate professor in the Department of Animal, Dairy and Veterinary Sciences at USU. Wang's research team employs genome engineering tools and modern assisted reproduction technologies to create transgenic animal models for human diseases. His lab is also actively pursuing a better understanding of the epigenetics of stem cells. Current projects in Wang's lab include gene targeting in Golden Syrian hamsters for creating viral infection disease models, creating transgenic goats as animal models for atrial fibrillation and lung cancer, establishing ES/iPS stem cells from important farm animal species, and immunological and genetic approaches for improving mastitis resistance in dairy cattle. Wang received his Ph.D. degree in Molecular and Cellular Biology from University of Massachusetts at Amherst in 2000.

Deborah Yurgelun-Todd, Ph.D. *University of Utah*

Deborah Yurgelun-Todd is a professor of psychiatry at the U of U School of Medicine, as well as the director of the university's Cognitive Neuroimaging Laboratory. Yurgelun-Todd's team at the Cognitive Neuroimaging Laboratory use a variety of imaging techniques to identify brain changes related to healthy brain development, as well as traumatic brain injury and psychiatric disorders. The lab investigates irregularities in the brains of people who have or are at risk for developing a number of major psychiatric disorders including depression, substance abuse, bipolar disorder, and schizophrenia. This knowledge may eventually result in better and more personalized treatments for patients who have or who are vulnerable to psychiatric disorders, or patients affected by traumatic brain injury. Yurgelun-Todd has a Ph.D. in neuropsychology from Harvard University.

MARK YANDELL, PH.D.

UNIVERSITY OF UTAH



Mark Yandell is an internationally recognized leader in software development for comparative genomics and the technical director for the Utah Genome Project. Yandell's team works at the intersection of genetics and computer science, developing new computational models for analyzing genetic data. The technology developed to complete the Human Genome Map has reduced the cost of genetic sequencing, making individual genetic maps available. The availability of individual maps creates the opportunity for personalized medicine, but in order to use this data effectively, new analytical approaches and computational tools must be developed.

Four of the most significant software projects developed in Yandell's lab include MAKER, a tool for gene annotation; VAAST, a tool designed to identify broken genes responsible for disease; Phevor, which analyzes genomic data in relation to phenotype; and Taxonomer, which genetically analyzes biological samples for the presence of pathogens or other microbes.

"The first thing you do after you sequence an organism's genome is annotate it, or in other words you find out where all the genes are, and what the structure of those genes are, and those gene models become the basic resource for further research on the organism," said Yandell.

His lab is also working on VAAST, a software tool that analyzes individual genetic data for genes responsible for specific variations. VAAST has many applications, including finding the causes of genetic diseases. It can also be used to find the genetic causes of non-disease variations in individuals; for example researchers have used it to find the genes responsible for color variation in pigeons.

Phevor, another software tool developed in Yandell's lab, matches genetic information with physical manifestations to identify possible causes of disease. Phevor's unique approach allows it to identify disease-causing genes more precisely than other computational tools. U of U researchers have used Phevor to identify genetic mutations associated with three specific diseases, according to a recent article in The American Journal of Human Genetics.

Phevor and VAAST are key innovations driving the growth of Omecia, a private company in the Bay Area affiliated with the U of U and USTAR. Yandell and his team develop the software tools, which are brought to market by Omecia.

A fourth method to analyzing genetic data developed in Yandell's lab is Taxonomer, which is capable of analyzing complex genetic samples – such as mucus, stool, or even soil samples – using DNA to identify the presence of pathogens and other microbes. Taxonomer opens up the possibility for "hypothesis-free testing."

In current approaches, a doctor may suspect that a patient's illness is caused by a specific germ and run a test for that germ. If the test is negative, the doctor comes up with another hypothesis and runs another test. In the meantime, accurate diagnosis and treatment may be delayed, and the patient becomes sicker. With "hypothesis-free testing," a sample can be compared with genetic profiles for thousands of microbes in a single test. This kind of data-intensive, complex analysis would be impossible without the algorithmic tools Yandell and his team have developed.

Yandell received his Ph.D. in molecular, cellular and developmental biology from the University of Colorado, Boulder in 1996. He spent three years at the Genome Sequencing Center at Washington University School of Medicine, St. Louis, and then three years at Celera. In 2004, he joined the Eccles Institute of Human Genetics at the U of U.

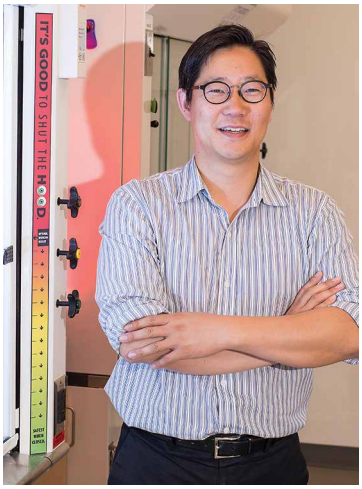
Genomics and personalized health initiatives
Utah genome project
Heritage 1K project
Center for Mendelian Genomics
Cohort identification, extension, data mining
UK 100,000 genomes
1 million vets
Obama's Precision Medicine Initiative
Call variants: what variants are present? Variant Graph
Prioritize variants: which variant causes disease?
Store, aggregate, catalog, query
Diagnostics developed Drugs developed
User interface: return results to clinicians and scientists
Patient is treated Family members tested. Genetic counselling Prevention measures
Utah Genome Project

MICRO/NANO SYSTEMS

Whether it's a miniature gas chromatograph for personal air pollution monitoring, the development of an artificial retina to restore partial vision to the blind, an implantable middle-ear microphone that could restore hearing to deaf patients without the external hardware necessary for today's cochlear implants, or the invention of a brain stethoscope that uses magnetomer arrays to detect neurons firing in the brain - the micro and nano communities in Utah are diverse and inventive. At the U of U, researchers, businesses and outside university researchers have the ability to utilize USTAR's resources and core facilities within the Nanofab in the James L. Sorensen Mollecular Biotechnology building.

HANSEUP KIM, PH.D.

UNIVERSITY OF UTAH



Hanseup Kim is aiming to bring an unprecedented level of detail to air pollution research with a wearable, wristwatch-sized version of the gas chromatograph, today's state-of-the-art pollution measurement system. Currently, refrigerator-sized gas chromatography equipment is not portable and must be used from a fixed location, so it cannot measure extremely localized effects. This is a crucial information gap, because individual exposure to air pollution varies widely depending on a person's daily activities, according to Kim.

A personal, wearable pollution monitoring system would vastly improve research on air toxins, because it would be able to create individualized, hour by hour records of exposure to a wide variety of pollutants. These records could help connect specific air toxins to specific diseases in a way that is not currently possible. "It is very hard to correlate personal exposure to personal diseases," said Kim. "It is not possible yet."

Eventually, detailed information about individual air pollution exposure could enable more accurate diagnoses, effective treatments, and successful government policy.

Miniaturizing the gas chromatograph is an ambitious project because this specialized piece of equipment is not routinely used for daily air pollution measurements. Of the 187 air pollutants identified by the EPA, air quality authorities routinely measure only five.

"We have air quality monitoring stations in Salt Lake City and across the nation; however, what can be measured is only five items: ozone, particulate matter, sulfur dioxide, nitrogen dioxide and carbon monoxide," Kim explained.

This relative lack of detail, combined with the fixed location of air quality measurement equipment, makes it impossible for researchers to pinpoint the effects of many air toxins.

Kim's wearable monitor would analyze all 187 air toxins, which requires miniaturizing a large number of components, most crucially a pump to regulate the flow of air molecules through the system without bulky fans. Kim developed the first practical gas micropump, about the size of a quarter, as a part of his PhD research. The pump uses an array of vibrating membranes, each 1 mm by 1 mm, to create air displacement and generate airflow. The miniature, wearable gas chromatograph project fits with Kim's overall research philosophy.

"My research philosophy is that I think there are a lot of unknown phenomena happening on a very small scale, in biological domains or nano domains or material domains, and I think those phenomena can be precisely manipulated, and also observed, by utilizing very small scale transductive mechanisms. I would like to investigate those mechanisms, and also using those mechanisms I can build devices," said Kim.

Kim joined the USTAR program as an assistant professor in electrical and computer engineering at the U of U in 2009, and he was promoted to associate professor in 2015. He received his B.S. degree in electrical engineering from the Seoul National University, Korea, and M.S. and Ph.D. degrees from the University of Michigan. From 2006 to 2009, he was a post-doctoral research fellow in the Center for Wireless Integrated Microsystems (WIMS), University of Michigan. Kim has received two prestigious national awards: the DARPA Young Faculty Award (2011) and the NSF CAREER Award (2012). He holds three patents and fifteen pending patents.

USTAR FACULTY

Gianluca Lazzi, Ph.D. *University of Utah*

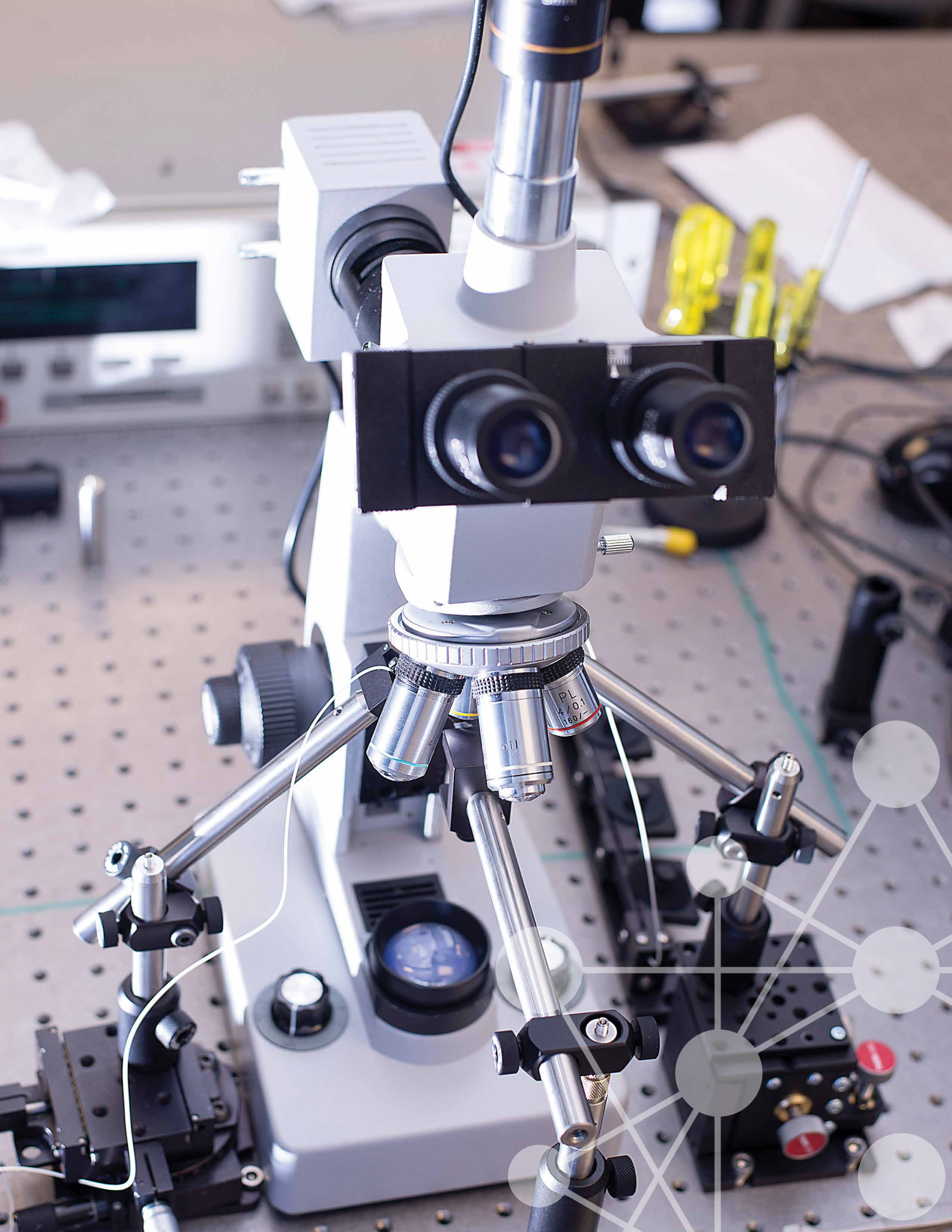
Gianluca Lazzi, USTAR professor and Chair of the Department of Electrical and Computer Engineering at the U of U, received his Ph.D. in electronics engineering from the University of Rome "La Sapienza," in 1994 and earned his Ph.D. in electrical engineering from the University of Utah in 1998. His research has been featured in such publications as Forbes, the Economist, MSNBC, MIT Technology Review and more. Lazzi has received various awards and honors, including the National Science Foundation CAREER Award in 2001 and the ALCOA Foundation Distinguished Engineering Research Achievement Award in 2009. For the past 15 years he has been researching the development of an artificial retina to restore partial vision to the blind and is the current principal investigator of an interdisciplinary and multi-national institution, the National Institutes of Health (NIH).

Carlos Mastrangelo, Ph.D. *University of Utah*

Carlos H. Mastrangelo is a USTAR professor in electrical and computer engineering and adjunct professor of bioengineering at the U of U. He is also the associate director of the Nanofab in the USTAR building at the University of Utah. His research focuses on microelectromechanical system applications and technology, microfluidic systems and integration, and design and modeling of MEMS fabrication processes. His research group is widely credited for pioneering the integration of DNA separation microchips with on-chip fluorescence detectors. He pioneered the fundamental theory of stiction (static friction) failure phenomena in MEMS, which aids in the manufacturing of air bag systems, MEMS based inertial guidance systems, MEMS RF switches, and MEMS-based Wii virtual reality handsets.

Marc Porter, Ph.D. *University of Utah*

Marc D. Porter is a USTAR professor of chemical engineering and chemistry and adjunct professor in bioengineering and pathology at the U of U. Porter's laboratory is focused on the development and validation of diagnostic tests using magnetoresistance (MR) and surface-enhanced Raman scattering (SERS) detection methodologies. He is collaborating his work on detection of Category A pathogens, tuberculosis, dengue and pancreatic and prostate cancer and his research on TB has recently led to the formation of Porter Diagnostics. He also works with scientists and engineers at NASA's Johnson Space Center on a water quality assessment technology created in his laboratory, now deployed on the International Space Station. He has expertise in analytical chemistry, interfacial science and nanotechnology and is also director of the Nano Institute of Utah. He received his B.S. in chemistry and his M.S. in physical chemistry from Wright State University, and received his Ph.D. in analytical chemistry from Ohio State.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RAJESH MENON, PH.D.

UNIVERSITY OF UTAH

Like most engineers, Rajesh Menon is an innovator. As associate professor of electrical and computer engineering at the U of U, he works to connect nanofabrication, computational optics and optical engineering.

Since his days at MIT, Menon was drawn to the commercialization of new technologies. He co-founded a company called LumArray while working as a research engineer at MIT's Research Laboratory of Electronics. The company uses Zone-Plate-Array Lithography to aid in micro- and nano-technology research. Menon also researched and patented Absorbance-Modulation-Optical Lithography at MIT, which uses near UV and visible light sources to overcome the diffraction barrier. At USTAR, he saw a supportive environment for commercializing technologies and joined the U of U in 2009.

Menon was recently in the news for his research on silicon photonics. The ultra-compact beamsplitter he developed divides light waves into two separate channels of information, which is used in photonic chips. Instead of using electrons as traditional electronics use, the chip would utilize photons (light).

"Usually the brains of a computer use electronics, which means you have electrons moving around in a silicon chip," said Menon. "But if you can do this same thing with light, it will be a lot faster and a lot more energy efficient."

With photonic chips, cell phones could last for a week on a single charge rather than a couple days. Big energy consumers, like data centers, could significantly cut back on power consumption. Photonic technology can be applied to other areas and facilitate designers to create things we cannot yet imagine. Menon collaborates with several professors at the University of Utah and other universities with his projects.

As an undergraduate student at Nanyang Technological University in Singapore, he was drawn to quantum mechanics while studying electrical and electronics engineering. In graduate school at Massachusetts Institute of Technology, he was introduced to photonics and saw how nanofabrication could be used as an enabling tool to apply in various disciplines.

Menon became an expert while receiving his master's and Ph.D. in electrical engineering and computer science at the Massachusetts Institute of Technology in 2000 and 2003, respectively. With these skills, Menon has led several projects in nanopatterning and nanoscopy with support from DARPA, the National Science Foundation (NSF), U.S. Air Force and the MIT Deshpande Center for Technological Innovation. Thanks to the equipment and resources USTAR contributes, he has been able to perform his research projects and create products.

Ninety percent of Menon's projects utilize the USTAR Nanofab at the U of U campus. The Nanofab sits between the engineering and the medical schools and similarly connects the two fields, which has helped Menon in his collaboration with biology professors.

Menon has received many honors for his work, including the 2013 NASA Early Stage Innovations Award, 2011 NSF CAREER Award and 2009 International Commission for Optics Prize. He currently directs the Laboratory for Optical Nanotechnologies at the U of U and was recently appointed as associate editor of Optics Express, the flagship journal of the Optical Society of America.

USTAR's support has been critical to all of Menon's projects. As with most successes, learning came as Menon tried and failed until he found solutions.

"For any type of scientific innovation you need to have some basic support from society. Sometimes tangible results take a very long time, like the internet, or sometimes it comes really quick. One needs to have patience and support."

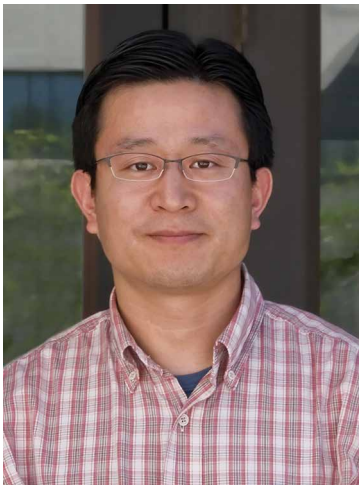
USTAR FACULTY

Saveez Saffarian, Ph.D. *University of Utah*

Saveez Saffarian is an independent investigator and assistant professor in the Department of Physics at the U of U, and studies virus replication implicated in diseases such as AIDS, Ebola, measles and rabies. Using computational biology techniques, his team recently identified a unique polymerase "sliding mechanism" that facilitates replication in NSS RSA viruses. The mechanism is a potential target for new anti-viral drugs. Saffarian's background in physics has enabled him to pioneer visualization techniques using fluorescent light and advanced microscopes to capture digital video of cellular processes in live cells. These techniques have helped Saffarian identify the role of the protein ALIX in the "budding" of HIV-1 viruses as they emerge from infected cells. He received BS and graduate degrees in physics from Sharif University in Tehran and Washington University in St. Louis. He comes to the U of U from a postdoctoral position at Harvard.

Darrin J. Young, Ph.D. *University of Utah*

Darrin J. Young received B.S., M.S., and Ph.D. degrees from the Department of Electrical Engineering and Computer Sciences at the University of California at Berkeley, in 1991, 1993, and 1999. He joined the U of U's electrical and computer engineering department in 2009, after spending ten years on the faculty at Case Western University. Young heads the U of U's Wireless Microsystem Laboratory, which focuses on developing the start-of-the-art sensors, actuators, interface and telemetry circuits, micro-power generation, and microsystem packaging technologies for wireless sensing, biomedical implant, RF communication, and industrial applications. One of Young's most promising projects is an implantable middle-ear microphone that could restore hearing to deaf patients without the external hardware necessary for today's cochlear implants. Young is an associate editor of the IEEE Journal of Solid-State Circuits and the chair of the IEEE Electron Devices Society MEMS Committee.

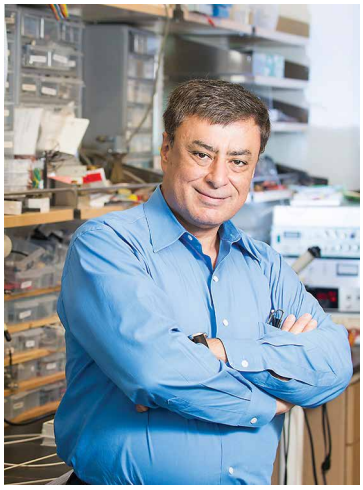


Ling Zang, Ph.D. *University of Utah*

Ling Zang is a professor in the U of U Department of Materials Science and Engineering, and an affiliate of the Nano Institute of Utah. His research focuses on nanoscale imaging and molecular probing, organic semiconductors and nanostructures, optoelectronic sensors and nanodevices, with the long-term goal to achieve practical applications in the areas of security, renewable energy, and clean environment. He helped found the USTAR-affiliated company Vaporsens Inc., which develops nanotechnology-based sensor devices. Zang received his BS degree from Tsinghua University and his Ph.D. from the Chinese Academy of Sciences. He was a post-doctoral associate at Columbia University and Bowling Green State University, and served as an Alexander von Humboldt Fellow, Erlangen-Nuremberg University.

MASSOOD TABIB-AZAR, PH.D.

UNIVERSITY OF UTAH



Massood Tabib-Azar, USTAR professor of electrical and computer engineering at the U of U, has always enjoyed the challenge of doing the near impossible. For him, this has meant designing, testing and manufacturing engineered devices – such as switches, amplifiers and sensors – that operate in ways standard electronics can't match. Tabib-Azar has been designing novel devices since he came to the United States from Iran in 1977.

One of Tabib-Azar's current projects is a brain stethoscope, a cap-like device that uses magnetometer arrays to detect neurons firing in the brain as the person wearing the device conducts everyday activities. The relationship between brain activity and behavior is a crucial area of research, according to Tabib-Azar. If successful, his device could be used to investigate neuron-firing patterns in patients with autism, schizophrenia, Alzheimer's, traumatic brain injury, migraines or depression. The brain stethoscope project is associated with the White House BRAIN Initiative, which uses NIH, NSF and DARPA funding to advance neurological research.

Current methods of measuring brain activity typically require patients to lie or sit in large chambers in specially constructed, magnetically shielded rooms. The brain stethoscope uses MEG technology, magnetometer arrays that measure magnetic fields generated by electric currents in the brain. These magnetometers are extremely sensitive; the current that is generated when neurons fire is exceedingly small, about one billionth of an amp. Electric lighting, by contrast, generates 2-3 amps. Tabib-Azar's team is electronically canceling magnetic interference, using the same principle as noise-canceling headphones, so the neuron-imaging device can be used in everyday environments.

Another way Tabib-Azar's team is extending the limits of electronic devices is by developing plasma-based sensors, switches and amplifiers. Plasma devices can operate in extreme environments where silicone-based electronic devices cannot. "The most important goal for this project is to come up with devices that can operate inside a nuclear reactor or in other very harsh, high temperature, high ionization environments," Tabib-Azar said.

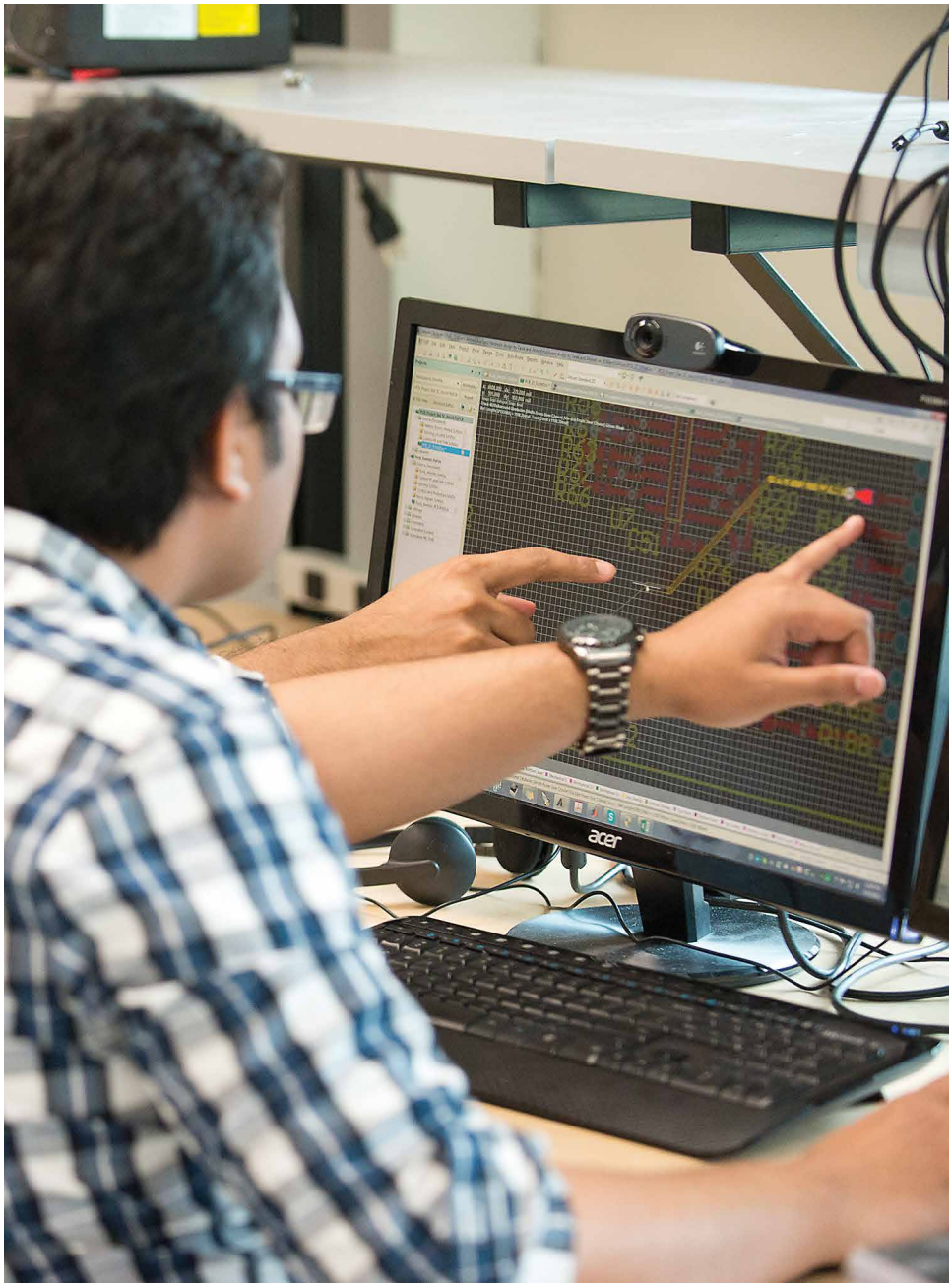
In addition to operating in extreme environments, plasma-based devices have promise for generating electromagnetic waves in the ultra-high frequency terahertz range. These ultra high frequency ranges have promise for sensing, imaging, and detecting chemical constituents of materials. A terahertz sensor could be developed to detect chemical changes in structural materials that signal aging and deterioration. Remote methods of imaging and sensing materials' chemical composition have a wide variety of applications, especially for safety and quality control. A remote sensor could be developed to detect flaws in concrete bridges, for example.

Tabib-Azar received his undergraduate and Ph.D. degrees at Rensselaer Polytechnic Institute in Troy, New York. He was on the faculty at Case Western Reserve University for more than 20 years and was also a visiting scholar at Yale and Harvard. Tabib-Azar was a program director at NSF in 2012-2013 and helped with some of its initiatives in brain research.

Tabib-Azar said USTAR support has brought many researchers to the state that wouldn't have been here otherwise. He believes government agencies such as USTAR play a valuable role in supporting long-range, innovative research efforts that are sometimes impossible for private companies with short-term financial goals. Support from a variety of agencies helps maintain technological superiority for the United States.

BIG DATA

The burgeoning field of big data crosses many academic and industry domains. The USTAR program has numerous scientists that are addressing this emerging field focused on computational tools that allow physicians, researchers in diverse areas from petroleum engineering to neural networks and policy makers to glean meaning from tetrabytes of data. In addition to finding the signal in the noise, researchers are developing tools to visualize results. As Big Data applications grow new methods for examining the data must be developed.



USTAR FACULTY

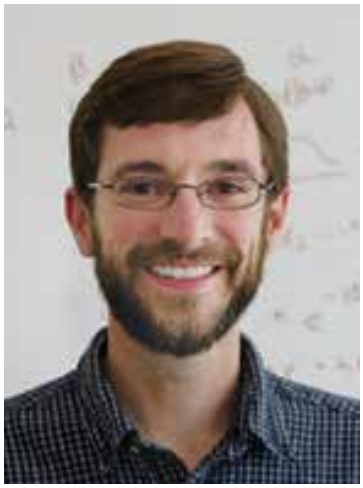
Orly Alter, Ph.D. *University of Utah*

Orly Alter is a USTAR associate professor of bioengineering and human genetics at the Scientific Computing and Imaging Institute at the U of U. She joined the University of Utah in 2010 from the University of Texas at Austin, where she is currently adjunct associate professor of mathematics. She was awarded an NSF Career Award in 2009, a National Human Genome Research Institute (NHGRI) R01 grant in 2007 and an NHGRI Individual Mentored Research Scientist Development Award in 2000. She works at the crossroad of mathematics, biology and medicine, creating models from mathematic frameworks to compare and integrate different types of large-scale molecular data. These models promote further understanding of the physical, cellular and evolutionary mechanisms that govern the activity of DNA and RNA. The genomic signal processing models Alter and her team are working on will bring physicians closer to predicting and controlling the progression of cell division and cancer.

Craig Caldwell, Ph.D. *University of Utah*

Craig Caldwell is a USTAR professor of film and media arts and adjunct professor of computer science at the U of U. Caldwell received the first creative Ph.D. in computer graphics and animation from the Advanced Computing Center for Art and Design at Ohio State University in 1989. He is currently game art track director of the Entertainment Arts and Engineering program at the U of U ranked number one by the Princeton Review. In the digital arts industry, Caldwell worked as a 3D technology specialist for Walt Disney Feature Animation in Burbank, CA, for films such as *Tarzan*, *Dinosaur*, *Chicken Little* and *Meet the Robinsons*. He also worked for Creative Training at Electronic Arts, the largest game company in the world. He has presented at various conferences including the Forum for Innovation (FMX) in 2013, the Special Interest Group on Graphics and Interactive Techniques (SIGGRAPH) in 2013 and 2014 in China, and the Mundos Digitales Conference on Animation, VFX, Videogames and Digital Architecture in 2014.

Tom Fletcher, Ph.D. *University of Utah*



Tom Fletcher is assistant professor in the School of Computing at the U of U. He received his B.A. in mathematics at the University of Virginia in 1999 and continued at the University of North Carolina at Chapel Hill to receive his M.S. (2002) and Ph.D. (2004) in computer science. He joined the U of U first as a postdoctoral researcher in 2004 then became research assistant professor in the Scientific Computing and Imaging Institute. Fletcher's research is focused on creating novel methods at the intersection of statistics, mathematics and computer science to solve problems in medical image analysis. He examines non-Euclidean geometric data derived from medical imaging and is currently collaborating with researchers in Autism and Alzheimer's diseases at the U of U on the statistical analysis of combined imaging modalities, including structural MRI, DTI, fMRI and PET in longitudinal studies.

USTAR FACULTY

Miriah Meyer, Ph.D. *University of Utah*

Miriah Meyer is assistant professor in the School of Computing and faculty member of the Scientific Computing and Imaging Institute at the U of U whose research focuses on designing systems that help people make sense of heterogeneous data. She develops visualization tools for scientists to integrate data with different structures and from different sources, allowing them to validate their data and models to develop new hypotheses and insights. She received her B.S. in astronomy and astrophysics at Penn State University in 1999 and earned a Ph.D. in computer science from the U of U in 2008. Between 2008 and 2011 she was a postdoctoral research fellow at Harvard University. During her last year at Harvard she worked as a visiting scientist at the Broad Institute of MIT and Harvard. Among her honors are the 2014 NSF CAREER award, 2012 Microsoft Research Faculty Fellowship and 2009 NSF/CRA Computing Innovation Fellow award. She was named a TED Fellow and PopTech Science Fellow in 2013 and was included on MIT Technology Review's TR35 list of the top young innovators and Fast Company's list of the 100 most creative people.

Tolga Tasdizden, Ph.D. *University of Utah*

Tolga Tasdizen is an associate professor in electrical and computer engineering at the U of U. Tasdizen leads an interdisciplinary research effort using high-resolution microscopy, PET and MRI imaging to study brain processes associated with Alzheimer's and dementia, to target drug trials and other treatments. His current research focuses on creating state-of-the-art image processing algorithms for biomedical and biological applications such as reconstructing neural circuit diagrams. He is also a member of the Scientific Computing and Imaging Institute. Tasdizen received his B.S. degree in Electrical Engineering from Bogazici University in 1995. He received M.S. and Ph.D. degrees in engineering from Brown University in 1997 and 2001.

Cem Yuksel, Ph.D. *University of Utah*

Cem Yuksel is an expert in 3D computer graphics and an assistant professor in the School of Computing at the U of U. His research interests cover a wide spectrum of topics in computer graphics, ranging from realistic interactive rendering to physically based modeling and animation. Commercial applications of his work include Hair Farm, a leading developer plugin for 3ds Max, used to model CG hair and fur. Yuksel has a BS in physics and MS in computer engineering from Bogazici University in Turkey. He received his Ph.D. in computer science at Texas A&M University in 2010.

UNIVERSITY LEADERS

The partnership between USTAR headquarters and leadership at Utah's research universities plays a critical role in maintaining relationships with researchers, as well as supporting their efforts to transition their technology out of labs and into high-paying, high-tech jobs for the local economy. In addition to their engagement with USTAR headquarters and faculty, University leaders lend their expertise, knowledge and time to bridge the gap between research and the commercial world.

NOELLE COCKETT, PH.D.

PROVOST, UTAH STATE UNIVERSITY

From growing up on a ranch in eastern Montana to traveling from Bangkok to Paris in one week, Noelle Cockett's love of research has taken her places. She has been a member of the Utah State University faculty since 1990 and was named executive vice president and provost of the university in 2013. Cockett was raised with strong agricultural roots, at her father's side of the family worked in farming and her mother's in ranching. She excelled in science in her youth, yet the only career options presented to her were doctor or veterinarian.

She entered Montana State University as a pre-vet student but was more inclined to the genetics classes that played off her strengths in math and science. She realized there were more career options in those fields after speaking to her professor, who opened her eyes to the wonder of research.

"Loving math and science, realizing that genetics combined those two and then finding out that there was an option of graduate school and a career as a university faculty member-I never wanted anything else. I wanted to be a researcher-scientist."

She graduated with her bachelors of science in animal science from Montana State University and went on to receive her master's and doctorate in animal breeding and genetics at Oregon State University. She had her first taste of research as a master's student measuring the level of antibodies that a newborn calf absorbs from colostrum, the first milk a mother produces for her newborn that is full of antibodies. Cockett was looking at factors that affected high antibody levels and discovered older mothers are more experienced at getting their calves to latch on sooner, therefore giving their calves more antibodies.

She began her professional career as a research geneticist at the USDA Research Center in Nebraska. There, she studied genetics of disease resistance in beef cattle and learned more about DNA from a biochemist she worked with.

Until then, she had focused entirely on cattle genetics, but USU offered her a position as an assistant professor with a research opportunity to study sheep. That switch proved to be a major turning point, as she is now internationally known for her work on sheep genetics. She is the U.S. coordinator for sheep genomics and a member of the International Sheep Genomic Consortium.

In her career, Cockett has discovered genetic causes for various traits, including a trait in sheep that makes their bones grow too much and a different trait that gives sheep big buttocks, named callipyge sheep. She was part of the group that sequenced the sheep genome and is currently working on a project to sequence additional sheep. Her greatest contribution to the field was with a small group of the International Sheep Genomics Consortium, where she developed and distributed resources that others involved in sheep genomic research use on a daily basis.

At USU, Cockett moved quickly to become associate professor and soon after professor. In 1999, she became interim dean of the School of Graduate Studies and in 2001 was named vice provost for academic affairs. From 2002-2013 she was dean of the college of agriculture while working as vice provost for extension in agriculture, and director of the Utah Agriculture Experiment Station. Now as provost, she oversees all USTAR efforts at USU.

"USU has an incredibly strong undergraduate research program, which is more about shadowing and getting engaged with faculty - that's what I'm proud of. It's very hands-on to let students know what that career really means."

DAVE WOOLSTENHULME

VICE PROVOST, UTAH STATE UNIVERSITY

Some are born to lead, some are born to follow and others are born to teach.

Dave Woolstenhulme, vice provost at USU, has always had a desire to teach. Woolstenhulme graduated with a bachelor's of science degree in education and later received his Master's degree in management and human resources, both from USU. After completing his education he and his family moved to Roosevelt, Utah when his wife accepted a teaching job for the Management Information Systems department at the Uintah Basin Campus.

Woolstenhulme was hired by USU in 1997 as an academic adviser, and progressively advanced to be director of student services, interim executive director and eventually associate director and professor in the School of Business. He completed his Ed.D. in education at the University of Wyoming in 2008 while teaching at Uintah Basin. He continues to hold his position as senior lecturer of management at the Huntsman School of Business at USU's main campus in Logan while working as vice provost.

Woolstenhulme worked at the Uintah Basin campus for 16 years and where he was struck by the critical role regional campuses provide to Utah students that are place-bound by their families or jobs. "As we take that education throughout the whole state, it's really a good opportunity for them to be able to better themselves and their families and for us to provide career opportunities," said Woolstenhulme.

While teaching at the Uintah Basin campus, Woolstenhulme won the 2008 Outstanding Professional Staff award and 2003 Program Development award. In 2012, Woolstenhulme was named president of Uintah Basin Applied Technology College, performing that role for two years before relocating to the Logan campus. He was named vice provost in spring of 2015. He continues to hold his position as a senior lecturer of management at the Huntsman School of Business at USU's main campus.

Woolstenhulme uses his extensive time and experience working in the Uintah Basin to assist Provost Cockett in overseeing USU's five regional campuses around the State. He facilitates opportunities and resources for students and faculty to work with the regional campuses. Since USTAR came to USU, Woolstenhulme has seen the initiative elevate the quality of researchers at the university as well as research opportunities for students.

"What I love about USU is that our students here, even at the undergraduate level, have a lot of access to work with not only the USTAR team, but with other faculty members here at the campus, as well as at the regional campuses."

When students get involved in research, they get an in-depth understanding of what they are studying while being involved in cutting-edge discoveries, Woolstenhulme said. His ultimate goal is to provide education throughout the state of Utah to meet the needs of all interested students. While working with USTAR he hopes to help spin out companies, provide jobs and increase opportunities in the state of Utah.

Woolstenhulme hopes to see the regional campuses prosper, but above everything, he wants to see the growth of the students. After all, that is what got him involved with teaching in the first place.

"To be able to connect with students. To be able to share what I have with them and see them progress throughout life; to me, that's what it's all about."

GREG JONES, PH.D.

ASSISTANT V. P. FOR RESEARCH, UNIVERSITY OF UTAH

Greg Jones describes himself as a little unfocused, but that versatility has allowed him to manage countless research projects and launch spin-off companies from various fields. Jones works as assistant vice president for research at the U of U and associate director of the Scientific Computing and Imaging (SCI) Institute.

After completing his undergraduate degree in physics at University of New Mexico, he worked as an optical engineer for CVI Laser Optics in Albuquerque until choosing to return to school. After applying on a whim, Jones received his Ph.D. in biomedical science from the University of New Mexico in 1997. He then came to the U of U for a two year post-doctoral fellowship in neuroimaging and went on to receive an MBA.

Jones began working for the SCI Institute in 2000 and left to work as Governor Jon Huntsman's science advisor from 2005-2007. In that position he learned about economic development in Utah and worked with the governor and the Governor's Office of Economic Development (GOED) to initiate the state's economic clusters program. He came to appreciate the economic strengths Utah has. "It's a remarkable state in manufacturing and technology, the way it embraces new technologies make it a perfect place for an initiative like USTAR," said Jones.

After his position at GOED, Jones worked as executive director of research at the Moran Eye Center and returned to the SCI Institute as associate director. He was the recipient of the 2007 Governor's Medal for Science and Technology and has made the v100 list for top entrepreneurs in Utah for several years. He was also one of the founders of Utah's Advanced Material Manufacturing Initiative, funded by the state and the U.S. Department of Commerce.

With only eight months at USTAR, Jones has recognized the value the program adds to Utah's universities and economy. The world-class researchers that USTAR attracts have taken the U of U's faculty to a new level of research. When those researchers teach undergraduate and graduate level courses, students receive top-notch education and are better prepared to be tomorrow's employees.

In his career, Jones has helped manage research projects on technologies for delivering drugs to the eyes, building software and creating new parts for airplanes. His current position allows him to maintain that flexibility while being involved in research companies that vary from improving blood measurement techniques for anesthesiologists to creating software to help farmers use unmanned aerial vehicles to better understand their crops. Jones hopes to contribute to research by increasing the number of USTAR spinout companies at the U of U, and is organizing commercialization teams to find markets for the technology.

"We're here to innovate and change the way we live," he said. "If we just do research and publish papers on that research, that's not maximizing our impact. To maximize our impact we need those publications to turn into technologies and those technologies to turn into companies."

USTAR is not a quick fix to an economic problem, but rather works off the states' assets to enhance research capabilities and seed the market with technologies. The fundamental research taking place now will create companies that will last and be a major proponent of Utah's economy for many years to come.

"USTAR is unique in the fact that it's not just trying to help spin-out companies become better spin-out companies, it's actually building a foundation of new innovation that will seed us far longer than just the spin-out companies," said Jones. "It will make Utah a place of true innovation in all the domains we've invested in."

GROW

CORE FACILITIES

USTAR has invested in two state-of-the-art research buildings to provide research space, core facilities and specialized equipment. These facilities are available to university researchers and can also be used on a fee-for-service basis by commercial partners where other commercial opportunities are not available. This expands the economic development impact of the USTAR investment.

JAMES L. SORENSON MOLECULAR BIOTECHNOLOGY BUILDING UNIVERSITY OF UTAH

UTAH NANOFAB

The Utah Nanofab advances leading edge research and facilitates economic growth by providing world-class nanofabrication facilities, infrastructure, and staff to academia and industry. The Nanofab also staffs, supports and administers the surface analysis and nano-scale imaging instrumentation located in the Micron Technology Foundation Inc. Microscopy Suite of the Sorenson Molecular Biotechnology Building. The Microscopy Suite is home to several other tools and instruments which are associated with other campus recharge centers, including the Health Sciences Center Electron Microscopy Core and the Nanomaterials Characterization Facility

SMBB FACTS

Total square footage: 208,000

LEED Gold Certification Awarded Sept 2013

Dedicated April 2012

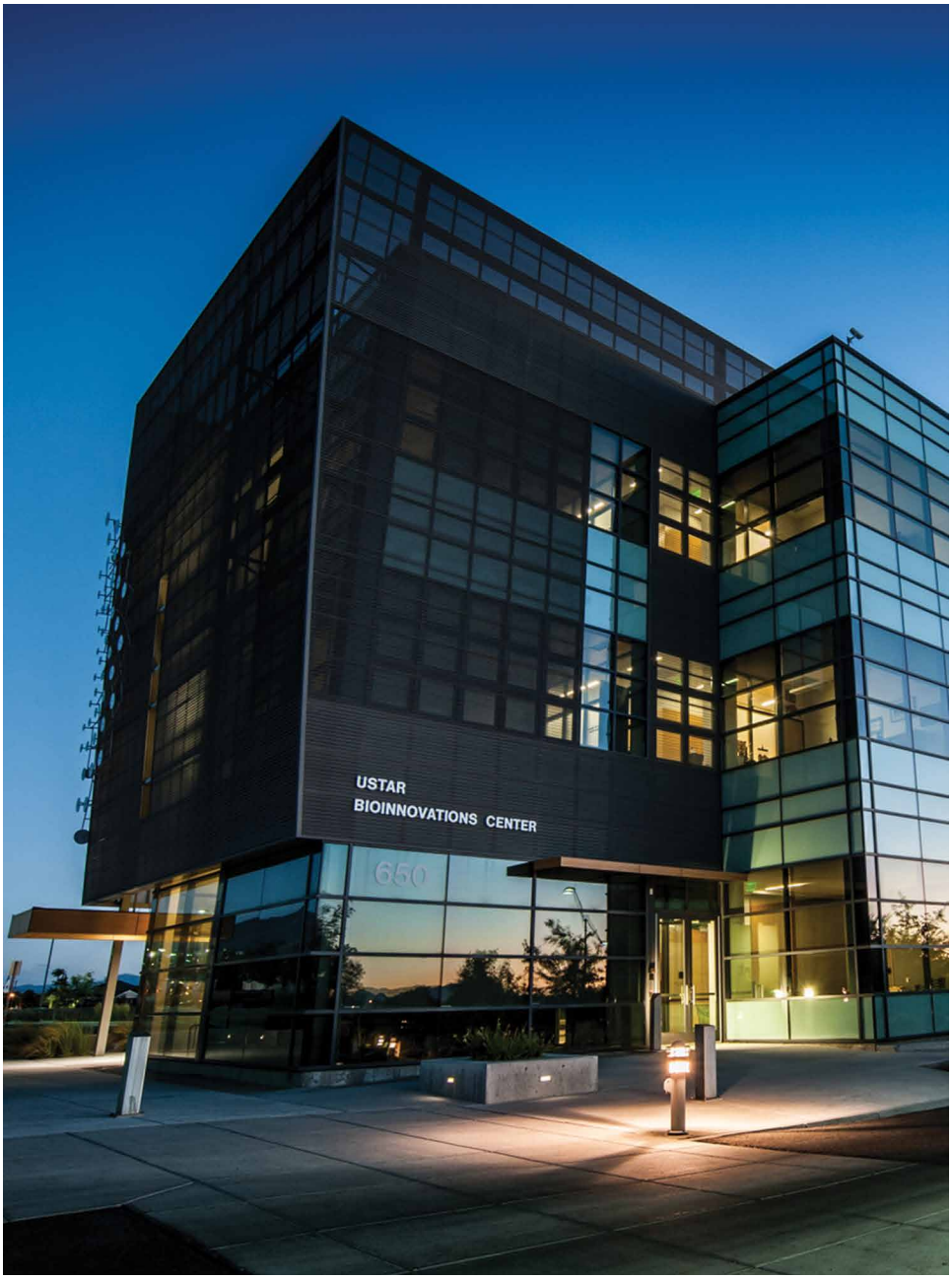
Open lab floor plan to encourage collaboration

The U of U's James L. Sorenson Molecular Biotechnology Building is the centerpiece of a visionary plan to accelerate research, development and commercialization at the interface of medicine, nanotechnology, engineering, pharmacology and digital media. The Sorenson Molecular Biotechnology Building contains a wet lab and research computing space, as well as a state-of-the-art nanofabrication facility with 18,000 square feet of cleanroom space, a bio-bay and a 5,300 square foot microscopy and materials characterization suite. With the facility's capabilities in both dry and wet nano, the Sorenson building is a critical component of leveraging Utah innovation and investment.

USTAR BIOINNOVATIONS CENTER

UTAH STATE UNIVERSITY

USU's BioInnovations Center houses highly advanced life-sciences laboratories and provides lab space in support of synthetic bio-manufacturing, advanced human nutrition, veterinary diagnostics and infectious disease and other innovation areas. The state-of-the-art facility also houses a Bio Safety Level 3+ lab. USU has also added a Biomanufacuting facility to enable industrial scale production of synthetic biology products. Both are positioned for industry collaboration.



TEST TRACK

USU's Electric Vehicle and Roadway (EVR) research facility, the first of its kind in the US, includes a 4,800-square-foot research building and an electrified quarter-mile oval test track.

The EVR enables advanced research into topics on energy efficiency and reduced emissions, including integration of renewable energy sources with electrified roadways and the grid, vehicle electric drivetrain design, energy storage systems, roadway materials and construction, and vehicle automation and security. The facility is fully networked, allowing data on roadway and vehicle performance to be collected in real-time.

BUILDING FACTS

Total square footage: 118,000

LEED Gold Certification Awarded October 2011, making it the first LEED Gold certified building on the Logan campus.

Dedicated October 2010

VWR
1000 mL

CHRISTIAN IVERSON

UTAH STATE UNIVERSITY

Christian Iverson of USU's Commercial Enterprises Team finds ways to shepherd innovative technologies – whether spider silk proteins produced by genetically modified goats, futuristic electric roadways, or intuitive rooms that adjust lighting and temperature in response to occupants' activities – through the development process from basic research to commercial success.

Iverson is at home at USU, where he received bachelor's degrees in business and biology, and later an MBA. After graduate school, Iverson worked for a decade in the biotechnology field, where he was able to take a new protein assay technology from early development through the startup phase and help build it into a mature business. His experience talking to potential customers and partners, discovering their needs, and developing solutions provides unique insights for the performance of his current role advising USU's USTAR researchers as they develop new technologies for commercial applications.

"The challenge with university technology transfer is having a technology that's ready to be implemented in the market," Iverson said. "The way we address that is by bringing industry partners into the process early, so they can provide input, funding and insight as to how this technology could be used in the market. The primary role that I play is bringing industry partners into the discussions with faculty members."

Recently, Iverson has been fielding a lot of inquiries about USU's spider silk project, spearheaded by Randy Lewis, USTAR professor of biology. "We've created a nice patent portfolio around spider silk," Iverson said. "With that intellectual property we've been able to approach a number of large and small companies, both national and Utah-based, that have expressed an interest in incorporating spider silk proteins into new products."

Iverson says another high-impact project is in-motion, wireless charging for electric vehicles, pioneered by Regan Zane, USTAR professor of electrical engineering. Zane and his team have already piloted wireless charging stations for electric vehicles, used by USU's "Aggie Bus." The bus starts the day with a full charge, and as it stops to pick up passengers, it stops over a charging pad, which wirelessly transfers electricity to the bus's batteries. The new system does not require electric vehicles to stop for a charge, but rather charges them as they pass by wireless charging stations. This technology is being tested on a quarter-mile oval track in Logan.

Besides these two flagship projects, Iverson is excited about USU's full slate of USTAR-funded projects in the fields of nutrition, energy development, intuitive buildings, bio-manufacturing, veterinary diagnostics, infectious diseases and veterinary science. He is pleased that USU is able to carry on its strong tradition of agricultural research.

Iverson views USU and USTAR as a mutually supportive partnership in which the university's dual missions of research and education both benefit from USTAR support. Iverson says the researchers in the program appreciate opportunities to see their discoveries affecting people's lives.

"I think all the USTAR professors understand the purpose of USTAR, and it is to develop technologies that can be taken to market," he said. "Each of the professors I work with has welcomed the idea of involving industry early on. They see it as a way to help them get their technology out into the world. I think scientists and researchers want to see their research doing something. One of the best ways to have your research do something is to have it in the market being used as a product. So if I can help them do that, they've been very open to it."

OUTREACH

OUTREACH MISSION
Create a science and technology ecosystem, which will mature and commercialize technology concepts into viable companies.

OUTREACH TASKS

- Assist businesses, applied technology centers, colleges and universities in building commercial applications for their research
- Connect market ideas and technologies in new or existing businesses or industries or in regional colleges and universities
- Support tech entrepreneurs through training, funding, incubator and accelerator programs
- Broker technology transfer by connecting capital, management and industry

USTAR Outreach supports technology commercialization activities across the state. The offices are strategically located around the State to provide support to tech entrepreneurs and USTAR researchers with innovative technology ideas to establish spinout companies.

USTAR TECHNOLOGY ACCELERATORS assist entrepreneurs in accelerating the development of start-up companies by providing resources and services. These accelerators emphasize rapid growth while providing support for obstacles that the start-up company may encounter.

USTAR TECHNOLOGY INCUBATORS focus on speeding up the growth and success of startup and early stage companies by providing space and core equipment to support tech startups. Incubation time varies for each company.

SBIR-STTR ASSISTANCE CENTER assists entrepreneurs and start-up companies in preparing and submitting SBIR-STTR applications. The SBIR and STTR programs offer more than $3 billion dollars annually to support the development of technology by small businesses across the nation. USTAR's SBIR-STTR Assistance Center helps technology-oriented businesses with new discoveries or innovative concepts get the funding they need to continue their path towards commercialization.

INDUSTRY SUPPORT includes working with established companies and corporations to connect them with applied research and new innovations, connecting startups with valuable resources to help facilitate collaborative partnerships. Industry support also helps to identify gaps in needed areas such as education and workforce development.

MENTORING/TECHNOLOGY BUSINESS SERVICES provided by industry experts offers help and resources to companies for refining plans and strategies. One-on-one mentoring can help with setting goals for success while developing business plans. USTAR regional offices and a network of experts combine knowledge, guidance and encouragement to help bring business possibilities to life.

USTAR provides PROTOTYPING SERVICES to early stage companies looking to validate their business model by providing a functionally limited proof of concept device. Prototyping support includes 3D printers, engineering assistance and machine shop time.

USTAR also works closely with other state agencies and partners to provide OTHER SERVICES to enhance their mission where possible, allowing USTAR to fulfill its directive of increasing innovation through research and business development.

OUTREACH

NORTH, *Teresa McKnight*

Prior to coming to Utah, Teresa held positions as executive director of the Montana State University Innovation Campus, CEO of the South Dakota State University Growth Partnership, executive director of the South Dakota State University Innovation Campus, and director of the Utah State University Innovation Campus. During McKnight's 24-year tenure developing university-related research parks, she raised more than $39 million in federal grants, state and private funding, developed 3 research parks totaling more than 360 acres, and recruited more than 90 high-tech companies to Utah, South Dakota and Montana. Teresa has extensive experience in university-related research parks, technology commercialization, incubation, business recruitment and development, entrepreneurship, tech-based economic development, management, administration, marketing, strategic planning and human resources.

CENTRAL, *Donna Milakovic*

Donna Milakovic graduated from Brigham Young University with a degree in English and a minor in Korean. Continuing her professional development, she has completed the U.S. Chamber of Commerce Institute of Organizational Management in Tucson, Arizona receiving her IOM designation. Before joining USTAR, she served as the executive vice president at the Utah Valley Chamber. Donna was president/executive director for the Lehi Area Chamber of Commerce for three years. In her first year as a Chamber President, she was recognized by the members as "Business Person of the Year" and was later nominated by her peers to serve on the Utah State Chamber Board of Directors. She participates in several professional and community organizations.

EAST, *Andrew Sweeney*

Andrew is the Director of USTAR East, which focuses on the commercialization of conventional, unconventional, and renewable energy products, and energy efficiency technologies. Andrew is also the Director of the Utah Energy Research Triangle (ERT), a competitive grant program aimed at fostering coordination among Utah's top research universities in order to advance energy innovation and development in Utah. He holds a B.S. in Chemistry from Virginia Tech and a Ph.D. in Physical Chemistry from the U of U.

OUTREACH

SOUTH, *Shirlayne Quayle*

Shirlayne is an entrepreneur with a strong background in connecting public-private, local-global interests to nurture innovators and foster innovation. Prior to joining USTAR, she spent 18 years developing programs and international partnerships in medical education, clinical research, technology innovation and commercialization, entrepreneurship and global leadership at the U of U. After moving to Southern Utah in 2012, she founded Q3 International, LLC to support leadership, innovation and entrepreneurial development, and was an associate director and adjunct faculty at Dixie State University. Shirlayne earned a B.S. in Anthropology and an MBA from the U of U. She is a U.S. State Department Global Innovation in Science and Technology (GIST) mentor, past-chair of the Utah Women in Higher Education Network, and active in local, state, national and international organizations that support girls' and women's leadership growth.

SBIR/STTR ASSISTANCE CENTER, *Mary Cardon*

Mary Cardon leads the USTAR SBIR/STTR Assistance Program (SSAP), located at and operating in partnership with the Salt Lake Community College Miller Resource Center in Sandy, Utah. The center works with Utah's technology companies exclusively on SBIR/STTR grants and currently has a better than 25% success rate for grants they assist with. Mary brings three decades of management experience to the center, coming most recently from GE Money where she led the proposal writer team. While there, GE Money won the GSA travel and procurement award in 2007 as well as many multi-million dollar state and private sector programs. Prior to joining GE, Mary worked in management and communications, with over 20 years in newspapers and small business in Idaho, California and Utah. Her experience includes project management, training, writing, marketing and sales. She is active in the community, volunteering with organizations improving the lives of women, children and the under-represented.

OUTREACH OFFICES

USTAR NORTH
218 South 200 West
Farmington, Utah 84205
385.226.8457

USTAR CENTRAL
815 W. 1250 South
Orem, Utah 84058
385.335.5300

USTAR EAST
423 Wakara Way, Ste 300
SLC, Utah 84108
801.585.9690

USTAR SOUTH
1071 East 100 So. Bldg C7
St. George, Utah 84770
435.216.8364

SALT LAKE CITY

SBIR-STTR ASSISTANCE CENTER
SLCC – Miller Campus
Corp Partnership Center
9750 So. 300 W.Ste 214
Sandy, Utah 84070
801.597.5239

BIOINNOVATIONS GATEWAY
2500 S State St Rm. 224
So. Salt Lake, Utah 84115
385.646.4625

THRIVE

In order to keep the technology ecosystem in Utah flourishing and closely connected, USTAR collaborates with industry partners who can benefit from its diverse, transformative portfolio. Historically, USTAR has focused on research capacity building. As we move forward, the organization will focus more on the "thrive" aspect of our mission and shift towards commercialization and addressing current industry leaders' science and technology needs. In addition to seeking recommendations to further develop our ecosystem USTAR is partnering nationally and internationally. For example, our partnership with KU Leuven will provide soft-landing in Utah for international companies to expand their technology development. Additionally, SRI International provided USTAR with programatic recommendations, which are listed on the following pages.

SRI'S ASSESSMENT/RECOMMENDATIONS

USTAR hired SRI International, an independent research and development non-profit, to conduct an assessment of the Utah Technology Ecosystem and recommend programs for USTAR to better align to gaps. SRI identified multiple gaps in the ecosystem (figure 3) and recommended new programs that would align more closely to the USTAR vision, mission and legislative intent.

Revamp and expand existing TOIP programs into a USTAR New Ventures Program: Redirect a portion of the funding currently going to university research capacity building to provide more early-stage funding and business coaching and mentoring for startup technology companies. This is an expansion of the Technology Outreach Innovation Program (TOIP) incorporating best practices from similar programs in other states.

Create a USTAR Industry-University Partnerships Program: Pilot a new program to help Utah companies solve technical challenges related to product commercialization through sponsored research projects at Utah colleges and universities.

Utah innovation system gap analysis

Category	Common challenge	Utah
Idea Generation	University R&D	++
	Business R&D	+
Innovation Culture	Risk aversion	++
Networks	Industry-university linkages	-
Talent	Serial entrepreneurs Sector specific knowledge	-
Risk capital	Pre-seed	-
	Venture capital	+/-

University R&D/ GDP 2012

1st quartile

Source: NSF

Total VC Investment Dollars 2014

9th ($783.2M)

Source: NVCA

Business R&D/ industry output 2012

2nd quartile

Source: NSF

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Figure 3. Summary of Utah innovation system gaps provided by SRI International based on 2015 study.

SRI'S ASSESSMENT/RECOMMENDATIONS

Pivot USTAR Research Capacity Building Program: Shift from talent recruitment to enhancing the productivity of both USTAR-recruited and existing faculty. This includes providing competitive funding for commercially-oriented research projects and other mechanisms to incentivize interdisciplinary and university-company connections. Align any future talent recruitment priority industry sectors and adopt best practices in implementation.

Refine USTAR Metrics: Adopt a new metrics framework that provides better alignment between USTAR programs and anticipated impacts (figure 4).

Recommended USTAR Metrics

Gap	Recommendation	Activities	Short-term Outputs	Long-term Outputs
Industry-University Linkages	Industrial Partnerships Program	Companies Assisted Projects Awarded	Solutions Found Follow-on Investment	New Sales/ Revenue New Direct Jobs Average Wage
Limited Risk Capital Managerial Talent	New Ventures Program	# of Companies Assisted # of Companies Awarded Pre-Seed Investment	Follow-On Investment	New Sales/ Revenue New Direct Jobs Average Wage
Research Capacity Building	Research Capacity Building	Faculty Hired Collaborations Infrastructure	Leveraged Funding Patents/Licenses Publications	University Ranking Research Jobs Average Wage

© 2015 SRI International

Figure 4. Summary of Recommended Metrics provided by SRI International based on 2015 study.

Memorandum of Understanding (MoU)

for Technology Collaboration between the Office of the Science, Technology and Research Agency (USTAR) of the State of Utah in the United States of America, and KU Leuven, University Hospitals Leuven, IMEC International and VIB (Flanders Institute for Biotechnology), all of the Kingdom of Belgium.

The Office of Utah Science Technology and Research Agency of the State of Utah in the United States of America and KU Leuven, University Hospitals Leuven, IMEC International and VIB, all of Belgium, have established this MoU to lay down their intention to formalize cooperative relationships to further collaboration and knowledge, technology and commercial transfers in support of economic development.

The parties hereby confirm their intention:

1. To foster collaborations between the signing parties to advance technology development and commercialization in its broadest sense.
2. To stimulate joint research endeavors that aligns the strengths of the signing parties.
3. To provide infrastructure and business counseling to effectively secure soft landing of companies and in establishing new markets between signing parties.
4. To encourage academic student and faculty exchanges in the fields of science and engineering.
5. To establish open communications for sharing best practices for economic development through technology investment.

KU LEUVEN MOU

The MoU is effective as of the date of the signatures below, and will remain in force for a term of one (1) year. However, each party has the right to terminate its participation under the MoU by providing a prior written notice to the other parties.

This MoU is intended to provide a general framework for further good faith discussions and for a long term relationship, and shall be non-binding in nature, without any legal obligations or implications whatsoever, except for the confidentiality obligations set forth herein. Parties agree to keep the existence and content of this MoU confidential, as well as any confidential information exchanged between the parties in the frame of this MoU. Such confidentiality obligation shall survive for a term of five (5) years as from termination of the MoU, unless agreed otherwise in a separate agreement between the parties. Each party shall bear its own costs or expenses incurred in connection with this MoU.

This MoU is witnessed by the Governor of the State of Utah and by the Governor of the Province of Vlaams-Brabant.

IN WITNESS WHEREOF, each of the parties has caused the MoU to be executed by its duly authorized representative in seven (7) originals, one (1) for each party,

- IMEC International, stichting van openbaar nut, Register of Legal Entities Leuven VAT BE 0817.807.097, with its registered office at Kapeldreef 75, B-3001 Leuven, Belgium
- VIB, VAT BE0456.343.923, Rijvisschestraat 120, 9052 Gent, Belgium
- Utah Science, Technology and Research (USTAR) Agency, 60 East South Temple, Salt Lake City, UT 84111
- KU Leuven, VAT BE0419.052.173, Oude Markt 13, 3000 Leuven
- University Hospitals Leuven, incorporated in KU Leuven, Herestraat 49, 3000 Leuven

For IMEC International

Luc Van den hove
CEO
Date: 09.06.2015

For USTAR

Ivy Estabrooke
Executive Director
Date: 9 June 2015

For University Hospitals Leuven

Marc Decramer
CEO
Date: 09.06.2015

For VIB

Johan Cardoen
CEO
Date: June 9, 2015

For KU Leuven

Wim Robberecht
Vice President
Date: 9/6/15

Koenraad Debackere
General Manager
Date: 9-6-2015

Witnessed by:

Governor Gary Herbert
State of Utah
United States of America

i.o. G. Deuke

Governor Lode De Witte
Province of Vlaams-Brabant
Belgium

Q. Val Hale
Executive Director, Governor's Office of Economic Dev.
Vice Chair, USTAR

Derek Miller
President/CEO, World Trade Center
Member, USTAR Governing Authority

PARTNERS

USTAR's programs are varied and diverse, and cover a broad spectrum within Utah's technology ecosystem. The collaboration and strategic vision from our partners enables USTAR to connect and support industry, small businesses, research and the technology sectors within the state to resources to meet and tackle the unique challenges they face while building companies, startups and early stage technologies.

Governor's Office of Economic Development

UTAH OFFICE OF ENERGY DEVELOPMENT
Advancing Utah's Energy Future

edcUTAH
ECONOMIC DEVELOPMENT CORPORATION OF UTAH

WORLD TRADE CENTER® UTAH

SALT LAKE CHAMBER
EST. 1887
UTAH'S BUSINESS LEADER

MountainWest Capital Network

UTC
Utah Technology Council™

BoomStartup
Mentorship-Driven Seed Accelerator

women tech council

BIOUTAH
UTAH'S INDEPENDENT LIFE SCIENCE ASSOCIATION

WBI
WAYNE BROWN INSTITUTE
.ORG

GROW UTAH

Governor's Office *of* Economic Development

LETTER OF SUPPORT

At the heart of any thriving economic environment is a strong spirit of innovation. More than 20 percent of all employed Utahns own their own business. As part of our mission at the Governor's Office of Economic Development (GOED), we work to increase innovation by sustaining the development of entrepreneurship and supporting the expansion of the existing Utah businesses. Our partners at USTAR are at the forefront of these endeavors, combining local innovation and global business to create a thriving technological ecosystem in Utah.

USTAR plays a critical role as a bridge between research, educational groups and the private sector. For example, their two facilities near Utah State University and the University of Utah provide direct links to bioscience and nanofabrication research. In the short years that both sites have been functional, USTAR has recruited more than 50 research teams, bringing hundreds of millions of dollars in research money for the state.

Collaborations between USTAR's recruited research teams have produced remarkable innovations such as Vaporsens bomb detection and WAVE, Inc.'s wireless power transfer between vehicles and roadways. Some USTAR-supported companies, such as ENVE Composites, have been incented by GOED's post-performance tax incentive program. USTAR is also involved with larger GOED-incented companies such as Edwards Lifesciences and Fresenius Medical Care.

USTAR's work impacts all six of the state's targeted economic clusters from incubation stages to global growth, as demonstrated by USTAR's involvement with the GOED-led trade mission to Western Europe this year. During this trade mission USTAR signed an MOU with KU Leuven, University Hospitals Leuven, imec and the Flemish Institute of Biotechnology in Belgium, further facilitating international collaboration in some of the world's top nanotechnology research.

GOED is proud to work shoulder-to-shoulder with USTAR in leading the nation with the best performing economy. This could not be accomplished so effectively without USTAR's exceptional work.

Sincerely,

Q. Val Hale
Executive Director
Governor's Office of Economic Development

LETTER OF SUPPORT

edcUTAH
ECONOMIC
DEVELOPMENT
CORPORATION
OF UTAH

USTAR Partnership with EDCUtah

The Economic Development Corporation of Utah (EDCUtah) is a private, non-profit organization that works with state and local government and private industry to attract and grow competitive, high-value companies and spur the development and expansion of local Utah businesses.

USTAR is a key partner for EDCUtah as we seek to create new jobs and capital investment in the state. When we are working with companies that are considering relocating or expanding, USTAR is an important asset because their work helps create an innovation infrastructure that companies are looking for. Specifically, USTAR's efforts to support small growing businesses in the technology and science sectors has helped EDCUtah attract other businesses in those industries. Technology companies want to be located near other innovative companies in order to draw productive advantage from their mutual proximity and connections. USTAR has increased the number of these businesses through their commercialization efforts and by their patronage of researchers and innovators across the state and in universities. EDCUtah also provides assistance to new companies created by USTAR researchers.

In addition, USTAR has positively impacted future workforce development by increasing the number of students with science, technology, engineering, and math skills. The increased collaboration between government, industry, and higher education will further the science and technology clusters and positively impact economic development in the region.

Sincerely,

Jeff Edwards
President & CEO
EDCUtah

LETTER OF SUPPORT

CHAMPIONING USTAR AS UTAH'S INNOVATION FRAMEWORK

Utah ranks among the top 10 states in nearly every economic performance metric. We have one of the most envied Knowledge Economies in the country. And this unbridled, thriving Innovation Community is no accident. It is a direct result of the collaboration between industry and research universities—namely, through three major economic development initiatives: the Engineering Initiative passed in 2001, the Utah Fund of Funds passed in 2003, and USTAR passed in 2006. These initiatives that we've put into place have fundamentally changed the capital and innovation structure of the state! They have also defined an ethos of collaboration between industry and innovation that have made Utah a model for the nation.

USTAR was a bold initiative for a small, conservative state with high expectations of its economic investments. It was—and continues to be—a tremendous success story. The Utah Technology Council (UTC) along with our business partners, the Salt Lake Chamber and Economic Development Corporation of Utah, were the drivers in the passage of USTAR and contributing to its vision: a $400 million investment over a 30-year period that would result in the creation of over 400 new companies and more than 121,000 new jobs. In the past decade, ensuring USTAR's ongoing funding has remained one of our highest priorities in the legislature, and we applaud our legislators, including our governors past and present and their agency executive directors, for continuing to recognize the value of the state's "innovation framework." We also fully support the new leadership of Ivy Estabrooke, as the new executive director, and the current USTAR board.

Speaking for all of UTC, including our members and board of trustees, we are enthusiastic about furthering the industry relationship with USTAR and continuing to build this holistic community of forces working together—it truly is a "positive perfect storm for growth."

Sincerely,

Richard R. Nelson
President & CEO
Utah Technology Council

LETTER OF SUPPORT

GROW UTAH

July 8, 2015
Ivy Estabrooke- Executive Director USTAR
60 E. South Temple - Third Floor
Salt Lake City, UT 84111

Dear Ivy,

We would like to express to you our support for your many USTAR efforts and specifically for those initiatives in which we jointly participate.

As a privately funded non-profit organization, which is dedicated to fostering innovation and business start-ups across the state, we have greatly benefited from our years of association with USTAR. The USTAR team has always been collaborative and professional, always open to good ideas no matter where they originate from and always committed to a shared vision of expanding Utah's technology based economy.

USTAR has been a key partner in many of our Grow Utah initiatives including specifically the sponsorship of our Concept to Company Innovation contests. As a main sponsor, USTAR annually joins with us in hosting five innovation contests in such diverse fields as outdoor products, video games and digital entertainment, medical devices and social/mobile app development. Annually, some 500 innovators and emerging entrepreneurs get their start by participating in these events and receive critical resources and mentorship to help them successfully launch and grow their business. The USTAR team provides leadership and vital insight to both our efforts as well as directly to the participating innovators and entrepreneurs, making Concept to Company a valuable driver of future innovation.

We feel strongly that USTAR is a key leader in identifying and developing the economic clusters that will be the basis for Utah's future economy. As leaders, we all share a role to foresee where innovation is heading and to begin early to stand up the economic clusters of the future that will continue to drive Utah's economy. Through its various programs and research initiatives, USTAR is vital to this effort. USTAR helps provide focus and direction on where key resources should best be placed in light of the rapidly changing world of technology.

We do so appreciate your personal outreach to private organizations like ourselves which has helped foster a spirit of deep collaboration among the public, academic and private sectors. Through this collaboration, our collective resources are more effectively used in a well-coordinated fashion achieving a much greater impact.

We trust that your good efforts and those of your team will continue and will ensure that these benefits I have mentioned, and the many more that your programs produce, will continue over the years to come.

Sincerely,

T Craig Bott

T. Craig Bott
President/ CEO Grow Utah

SALT LAKE EST. 1887 CHAMBER
UTAH'S BUSINESS LEADER

LETTER OF SUPPORT

Dear USTAR Members,

As Utah's largest and longest-serving business association, we understand that the spirit of collaboration stands as a hallmark of prosperity in our community.

Contributing to the collaboration that we enjoy in Utah is USTAR, an organization that has transformed the technology ecosystem of our state. We are proud to support all their efforts, dating back to their inception in 2006.

The future is coming whether we want it to or not, and to continue to succeed as a state we must work together. The connections that USTAR has created to engage our local entrepreneurs with Utah's research universities have helped to broker ideas, new technologies and services.

USTAR is the ultimate catalyst for connecting innovators and entrepreneurs around the state of Utah. Their work has supported the tech industry by creating new ideas for tech–based start-up firms. As our population continues to expand, there is not a single industry that will not benefit from having a strong, influential tech sector partner such as USTAR.

We believe USTAR will continue to succeed at connecting the technology base we have in Utah and further develop an economic climate that allows Utahns to succeed in tech industries, obtain high-paying jobs and help us keep on our track to truly be "Silicon Slopes."

To the technology future of our state,

Lane Beattie
President and CEO
Salt Lake Chamber

175 E. University Blvd. (400 S.) Ste. 600 Salt Lake City, Utah 84111 Office: 801.364.3631 Fax: 801.328.5098 www.slchamber.com

EPILOGUE

This annual report responds to the requirements of Utah statute (63M-2-401(2)). This epilogue provides the additional required data that did not have a natural place in the narrative review. Following this section you will find the legislative auditor's report and the USTAR response to the auditor's report.

In this annual report, we define project, operation, activity, program and service as an activity that receives a specific line item in the USTAR budget {63M-2-401 (2)(a)}. This includes each researcher recruited as part of the USTAR program at the U of U and USU ("USTAR researchers"), each of the programs administered by the TOIP, USTAR HQ office and buildings or offices that receive funds through the U of U or USU that are not specifically aligned to a researcher recruited by USTAR.

Historically, USTAR researchers were budgeted and described as teams; here we are focused on the individual researchers as the diversity of members of specific teams makes it difficult to accurately capture their work and budget. The narratives that respond to this requirement can be found in the SEED (pg. 20), GROW (pg. 52) and THRIVE (pg. 58) sections of the report.

The GA has implemented multiple processes in FY15 to measure progress, performance and define scope for each project, operation, activity, program and service {63M-2-401 (2) (b)}. Criteria vary across projects and programs based on the technical domain, maturity of project and funding value. For many of these measures, FY15 was the first year that the data was collected. Therefore, there is no baseline to compare performance. In subsequent years, USTAR will be able to assess progress for maturation of specific technologies, research agendas and programs designed to advance the commercialization of technology against the baseline provided here. Given the limited data history and the timeline associated with technology development (often 10-40 years), leading measures and qualitative measures may be more meaningful for measuring impact and progress. It is also critical to recognize that the development and commercialization of technology is an art and there are no standard comparisons or benchmarks that are definitive early indicators of a technology's impact.

Research University projects, operations activities and programs:

In November of 2014 the GA reviewed each of the research teams at the U of U and USU, examining the technical progress and commercialization potential of the work as part of the USTAR Confluence workshop. In addition, the GA directed the USTAR staff to meet with the individual researchers receiving USTAR funding and assess their progress and identify the individual technologies under development. These technologies were scored for technical maturity, market fit and commercialization. Finally, in the budget process for FY16, each USTAR researcher was required to provide research achievements for the previous year (FY15) and research goals for FY16, which will provide a measurement metric for review prior to FY17 budget approval process. The template of required information for these progress/budget briefs are available by request.

Quantitative measures of progress for each USTAR researcher included federal funding expended, other funding expended, disclosures of new inventions, patents received, IP licensed, SBIR/STTR contracts or subcontracts, individuals hired in research groups and their salaries not paid by USTAR funding and spin out companies that were started were the metrics examined by the USTAR GA and are available in appendix C. As explained in the challenges section of this report, this data was requested by USTAR from the research universities. USTAR does not have the authority or the capacity to validate each number provided by the research universities. The FY15 contracts between USTAR and the research universities required that the universities provide accurate responses to requests from USTAR. In addition, each university has certified that the numbers are accurate.

It is also important to note that currently there is no way to collect SBIR/STTR contracts/subcontract data from the research universities. This information is not tracked by the universities through a formal system and therefore we have to rely on self-report by the researchers, which is inherently unauditable. The use of federal and other funding expended rather than funding awarded was collected, as it better reflects the economic impact of the USTAR program on

Utah's economy. It is also a more accurate measure, as frequently the amount of award of federal grants is not the actual amount received due to budget cuts or constraints at the federal level.

Technology Outreach Innovation Program (TOIP):

USTAR's TOIP seeks to create a science and technology ecosystem which will functionally mature and commercialize technology concepts into viable entities. TOIP has provided services to technology entrepreneurs, including connecting them to viable intellectual property at the State's universities, providing engineering and prototyping services, connecting them to large industry partners, mentoring, networking, competitively awarded loans through the Go-To-Market program, incubation space and assistance in proposals for Federal SBIR/STTR funds.

For the first time USTAR hired an independent third party to conduct an economic impact study of the TOIP activities. Due to high turnover in these offices, prior employees not keeping records and the distributed nature of the programs, there was not a historical record of all companies/individuals worked with from the initiation of TOIP. This data serves as a baseline for future years. Our independent assessor surveyed all companies that had worked with one of the USTAR TOIP offices.

Summary statistics from the study are based on the economic impact findings from 94 responses to a survey of 376 USTAR TOIP client companies. What is reported is only what was received in responses; there was no extrapolation based on the sample size to the whole cohort. Therefore, these numbers reflect a conservative measure of the economic impact of the TOIP. In 2015, these early-stage startup companies reported the following impacts to which USTAR assistance contributed, including:

- $26.4 million of total cumulative follow on investment
- $5.76 million in 2015 sales from a recently commercialized product or service
- 51 full-time employees and 63 part-time employees
- 14 "high-quality" jobs
- $4.99 million in 2015 wages
- $549,744* in 2015 tax revenue
- $3,498.13 in fees collected by TOIP

**The methodology used to estimate the tax revenue for the TOIP economic impact was calculated using IMPLAN, a formal model of economic impact. An estimate was used because USTAR does not have access to tax returns for the companies and/or individuals that had increased revenue or income following use of services from USTAR. Details of the IMPLAN model can be found at www.implan.com.*

EPILOGUE

USTAR Headquarters (USTAR HQ)
USTAR HQ has been examined in terms of budget spent on oversight and administration compared to other state agencies with similar budgets, and to determine the proper staffing capabilities needed for the agency structure and the oversight reporting required. USTAR-HQ's budget was approximately three percent of its total budget. The role of USTAR HQ will change in FY16, expanding responsibilities specifically to manage all procurement, financial management, contracting and increased budget oversight with the inclusion of the TOIP personnel and their activities as part of the USTAR program, instead of managed by host universities. This will reduce the overall administrative cost of the program.

Funding for the USTAR initiative {63-M-2-401-2 (d)}.

Appropriation Name	Legislative Appropriation Amount	Actual Expenses
USTAR Administration (CUA)	$1,279,616	$916,733.96
USTAR University of Utah Research Teams (CVAA)	$12,808,199	$10,002,164.49
USTAR Utah State University Research Teams (CXAA)	$7,650,693	$6,301,558.13
USTAR Technology Outreach and Innovation (CYAA)	$3,243,261	$2,611,289.36
Total Appropriation	$24,981,769	$19,831,754.94

NOTE: The actual expenses in FY15 were low compared to appropriation in all categories. For the Administration and TOIP lines, this was largely due to changes in staff that took time to replace.

The funding used for USTAR researchers at both the U of U and USU in the form of startup packages used for recruitment and the ongoing salary paid retains these faculty in Utah. If the USTAR appropriation was discontinued, these faculty would leave and the majority of federal funds would discontinue in Utah.

Notes on the Commercialization Revenue:
There is not a simple and straight forward methodology to capture the unrealized commercialization revenue anticipated. Any amount would be an educated guess and would not be auditable, and would likely provide a misconception of the actual potential revenue. USTAR recommends that as part of the five-year review of USTAR required by statute, an independent assessment of USTAR's IP portfolio be conducted.

It is important to note that in addition to the commercialization revenue defined, the companies that license IP from the universities and stay in Utah may have a larger impact on the Utah economy than just the royalties on the licenses from the universities. For example, Nanosynth, a spin-out of USTAR technology from the U of U has raised additional federal funding and has employees in Salt Lake City. All of these contributions are not captured under current statutory metrics, but will be collected in future years.

In FY15, no lease revenue was received from the buildings which the USTAR GA holds title, as there was an MOU signed in FY14 that expired at the end of FY15 that did not require payments. In FY15, USTAR signed a lease with the U of U codifying the terms and conditions of the use of the building effective FY16. While negotiations are underway with USU for a lease, as of this writing it is still not signed.

See figure 5 for the name of each business entity receiving a grant or other incentive as a result of the USTAR initiative.

Total operating expenses or current expense for the entire USTAR program is $6,287,939.70. Information on

salary, benefit and travel expenses can be found in Appendix A, Tab B.

USTAR can provide detailed expenses that it paid for the buildings the GA holds title to, but is unable to validate the information on total building expenses from the U of U and USU. Details on the expenses for the TOIP program can be found in Appendix A, tab B.

Jobs created by the USTAR initiative include both the jobs that are created by USTAR directly funding positions, those created at the universities paid for by USTAR funding, by federal funding received by USTAR researchers and jobs created by companies that worked with the USTAR outreach program. USTAR can only validate data for USTAR employees and the amounts paid by USTAR to researchers at the universities. SRI International's TOIP Economic Impact Study (available at www.ustar.org) provides the data on jobs they were able to collect.

Hiring of employees is considered a business sensitive fact. Our independent assessor was able to collect information with the assurance that only aggregated data would be provided to USTAR. The legislative auditor has been provided the data collected to validate, but we are unable to provide a publicly releasable list.

USTAR does not have statutory authority or a mechanism to request tax revenue from companies assisted by USTAR. Our independent assessors used the IMPLAN methodology to calculate an estimate of the tax revenue generated from USTAR's outreach program as $549,744*. Please see the SRI TOIP Impact Report available at www.ustar.org for a further description of this estimate. We do not have a mechanism to estimate the tax revenue generated from the individual tax returns of USTAR employees or university employees funded

Company Name	Award Value
Audiencein LLC	$5,000.00
Auto Repair Match LLC	$5,000.00
Boomstick	$2,500.00
ChondroStrike	$5,000.00
Coolhotnot	$2,500.00
Dealtik Corp	$7,500.00
Flip LLC	$2,500.00
Fosh Foot Care / SoniPed	$12,500.00
Good N Useful Supply LLC	$10,000.00
Inertial Sense	$7,500.00
Inneuvate LLC	$10,000.00
Innovated Sports	$2,500.00
Jobpiper	$7,500.00
Kiband LLC	$7,500.00
Lean Six Sigma Toolbox Business Engineering	$10,000.00

Company Name	Award Value
Lion Heart Innovations	$10,000.00
Medi + Swarm LLC	$2,500.00
Mura Interactive	$12,500.00
NOMO	$2,500.00
Nu Team Freedom	$2,500.00
Our Local Bounty	$25,000.00
Pura Scents	$5,000.00
Sentius Technologies	$2,500.00
SimpleNexus LLC	$5,000.00
Skeduna LLC	$10,000.00
Snorehero	$12,500.00
Solar Ninja LLC	$2,500.00
Somnus Medical LLC	$5,000.00
Vidalert LLC	$2,500.00
Wild Hair Technologies	$7,500.00

Figure 5.

EPILOGUE

by USTAR. This would require a legislative action to require the Utah Department of Tax to provide this data to USTAR.

IP assets generated by research teams recruited by the USTAR initiative are listed in the appendix. USTAR statue identifies the USTAR share in the commercialization revenue as 33.4 percent of the initial $15 million of IP revenue after the costs of IP protection and the individual researchers portion of IP are paid. After the first $15 million, USTAR will receive 50 percent of the post IP protection and researcher portions. Terms and conditions of each licensing agreement vary by technology sector, specific technology and typically change over time. In addition, many do not have any return until there is an equity event for the company. It is not possible to provide a reasonable estimate of the USTAR share of the revenue until there is an equity event for each company that has licensed IP.

During the course of the development of this annual report it has become apparent that USTAR needs better methods of tracking the equity events for companies that license technology. We are working with the Technology Commercialization Offices at each university to assure accurate tracking. This has included adding USTAR specific language on the disclosure forms when a technology is first disclosed to the Technology and Venture Commercialization office at the U of U and agreement to provide copies of license agreements and quarterly or annual reports directly from the companies to USTAR.

In addition, the USTAR GA Commercialization Sub-Committee reviews all licensing agreements prior to the universities signing them. This committee also meets quarterly to review the commercialization progress and the terms of the licensing agreements. Finally, through the Attorney General's office USTAR will retain counsel with expertise in IP and licensing to review all future agreements.

Private equity investments into the USTAR initiative could be defined in multiple ways. One way that private equity investments are made is through contracts directly with the research universities for specific work. The other is for direct investment into private companies that have either spun-out of the research universities or that have worked with the USTAR outreach program. USTAR currently has no way of tracking these investments except through self-report of the companies. In the case of those companies that worked with our outreach program, our independent assessment identified $26.4M in follow on investment. We believe this is a conservative estimate as it reflects only 25% of those companies that worked with the USTAR outreach program.

Data for FY14 (July 1, 2013- June 30 2014) was deemed unauditable by the legislative auditor; we therefore do not have historic data to provide for comparison. If the annual report passes the audit this year, we will use FY15 as the benchmark for performance in future years.

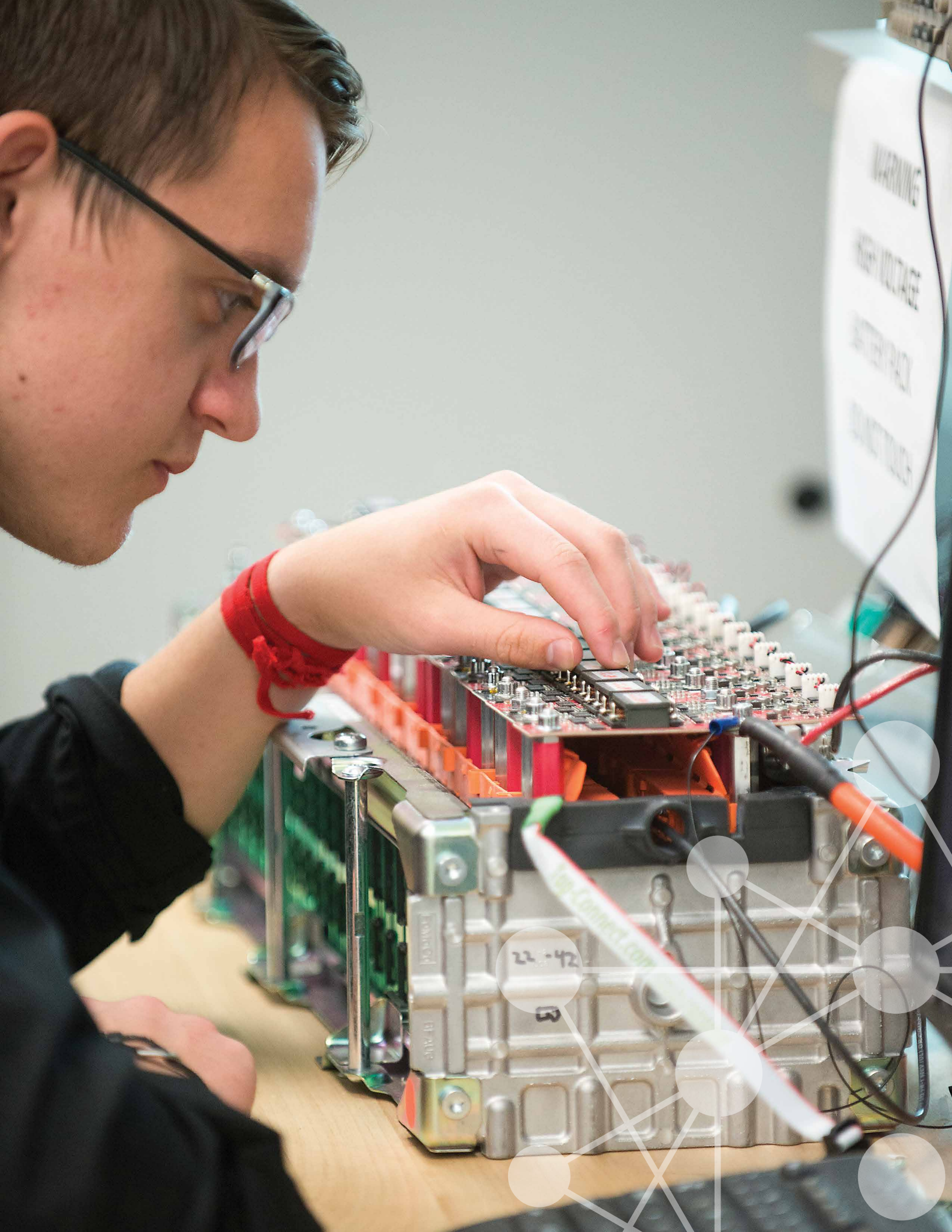
The Bayh–Dole Act or Patent and Trademark Law Amendments Act (Pub. L. 96-517, December 12, 1980) defines the requirements of separating the investigators return on commercialization revenues.

Contact information of officials knowledgeable and responsible for each project, operation, activity, program, or service:

University of Utah Activities:
Dr. Thomas N. Parks, Vice President for Research, University of Utah, 201 Presidents Circle, Room 210, Salt Lake City, UT 84112-9011, (801) 581-7236, tom.parks@utah.edu

Utah State University Activities:
Dr. Noelle Cockett, Provost, Utah State University, 1435 Old Main Hill, Logan, UT 84322-1435, (435) 797-1167, noelle.cockett@usu.edu

USTAR Administrative and TOIP Activities:
Dr. Ivy Estabrooke, Executive Director, USTAR, 60 E. South Temple 3rd Floor, Salt Lake City, UT 84111, (801) 538-8709, iestabrooke@utah.gov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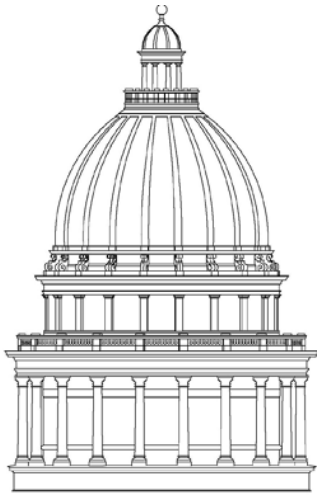
AUDIT REPORT

REPORT TO THE

UTAH LEGISLATURE

Number ILR 2016-A



USTAR Annual Review: Performance Outcome Reporting Remains Under Development

January 2016

Office of the
LEGISLATIVE AUDITOR GENERAL
State of Utah

STATE OF UTAH

Office of the Legislative Auditor General

315 HOUSE BUILDING • PO BOX 145315 • SALT LAKE CITY, UT 84114-5315
(801) 538-1033 • FAX (801) 538-1063

Audit Subcommittee of the Legislative Management Committee
President Wayne L. Niederhauser, Co–Chair • Speaker Gregory H. Hughes, Co–Chair
Senator Gene Davis • Representative Brian S. King

JOHN M. SCHAFF, CIA
AUDITOR GENERAL

January 2016

TO: THE UTAH STATE LEGISLATURE

Transmitted herewith is our report, **USTAR Annual Review: Performance Outcome Reporting Remains Under Development** (Report # ILR 2016-A). The objectives and scope of the audit are explained in the Introduction.

We will be happy to meet with appropriate legislative committees, individual legislators, and other state officials to discuss any item contained in the report in order to facilitate the implementation of the recommendations.

Sincerely,

John M. Schaff, CIA
Auditor General

JMS/lm

REPORT TO THE

UTAH LEGISLATURE

Report No. ILR 2016-A

USTAR Annual Review: Performance Outcome Reporting Remains Under Development

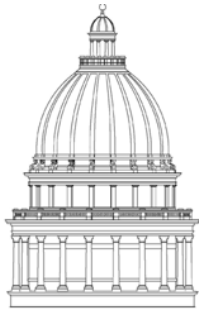
January 2016

Audit Performed By:

Audit Manager	Rick Coleman, CPA CIA
Audit Manager	Brian Dean, CIA CFE
Audit Supervisor	Candace Ware

Office of
LEGISLATIVE AUDITOR GENERAL
State of Utah

Report Number ILR 2016-A
January 2016



USTAR Annual Review: Performance Outcome Reporting Remains Under Development

While the Utah Science Technology and Research Initiative (USTAR or the initiative) has made progress in improving its performance outcome reporting in some areas over the prior year, a formal data collection and reporting process still needs to be fully implemented. Also, USTAR reports it has not received from its partners key commercialization and economic impact data, so the metrics remain either unavailable or incomplete in the initiative's fiscal year 2015 annual report. USTAR requires continued improvement in these areas to complete effective tracking and reporting of performance information.

USTAR reports that the reporting of key commercialization and economic impact metrics remains either unavailable or incomplete due to a lack of information from the universities.

According to statute, commercialization revenue sharing applies to the USTAR activities at the two main research universities: the University of Utah (U of U) and Utah State University (USU). Statute requires USTAR to include an accounting of such commercialization revenues in its annual report. In addition to the commercialization activities at the main research universities, USTAR is also required to report annually other outcomes across all its programs, such as jobs created and state tax revenues generated. USTAR refers to a collection of such metrics as "economic impact" outcomes. This is important as it establishes the structure of this report. Following the introductory section of this report, there are three main sections that detail our audit findings:

USTAR needs to strengthen its outcome metric reporting process.

- **USTAR Needs to Strengthen Its Outcome Collection and Reporting Process**. As recommended last year, USTAR should implement a formal and detailed performance metric reporting process. USTAR indicated it now requires the research universities to provide outcome reporting via budget-approval contracts. However, the initiative must take additional steps to ensure outcome information is accurate and reliable. Also, USTAR's internal auditor should develop a routine audit process that collects and reviews a sample of source documentation for performance metrics reported by USTAR's partners.

USTAR states a reporting of commercialization metrics is unavailable because the research universities have not agreed on such metrics.

- **Research University Commercialization Metrics Are Incomplete and Economic Impacts Unavailable.** While early commercialization metrics for the U of U and USU were provided in USTAR's fiscal year 2015 annual report, the initiative was unable to report later commercialization metrics, such as an accounting of actively licensed technologies and their associated revenues and percent-sharing terms. USTAR states that the lack of this data is due to the research universities having not agreed to such metrics. In addition, USTAR reports that negotiations with the universities are still ongoing after nine months to determine when indirect benefits to non-USTAR faculty qualifies the initiative to share in those revenues. Lastly, USTAR states that it did not include estimated economic impact outcomes for the research universities in its annual report because the universities did not provide the data needed to make such estimates.

While the magnitude of such occurrences is unknown, our limited test of outreach survey responses revealed a respondent changed their answers and an instance of survey-response bias.

- **Outreach Economic Impact Outcomes Rely on Self-Reported Data.** The initiative's fiscal year 2015 annual report states that management hired a consultant to complete a new survey of TOIP clients and compile economic impact estimates. USTAR states that this methodology is an industry best practice. We credit USTAR and its consultant for using a conservative approach to estimate economic impacts. We conducted a limited test of the survey responses and found that respondents have difficulty estimating how much of their success should be credited to USTAR. While the magnitude of such occurrences is unknown, our limited review found an instance of changing answers from a respondent and inaccurate answers from another respondent due to survey-response bias.

Audit Scope and Objectives

Utah Code 63M-2-401 requires USTAR to produce an annual report that details the initiatives revenues, expenses, and performance outcomes. In conjunction, ***Utah Code*** 63M-2-402 requires an audit to be conducted of USTAR's annual report by the Office of the Legislative Auditor General or by an independent auditor engaged by our office. The intent of the audit is to verify the accuracy of the information included in USTAR's annual report.

Last year was the first year USTAR was subject to these statutory reporting requirements. Our office conducted, in part, a review of USTAR's key performance metrics for the 2014 fiscal reporting year, as contained in the report: *A Follow-up Review of the Utah Science Technology and Research Initiative (USTAR) (Report Number 2014-14)*. During that prior review, we attempted to collect a sample of source documentation needed to determine the accuracy USTAR's summaries of performance metrics. However, we encountered delays in receiving source documentation from the research universities or received documentation inconsistent with the original metric summaries.

Similarly, this year we selected a limited sample of summary commercialization statistics included in USTAR's fiscal year 2015 annual report and asked staff to gather the relevant source documentation from the U of U and USU in order for us to test the accuracy of the reported outcomes. For economic impact metrics, USTAR reported summary metrics for its outreach program, which were gathered through a new survey method. We received the survey responses, which included respondents' contact information. We then contacted a small sample of respondents to test the validity of their survey answers. USTAR staff stated to us that the research universities did not provide economic impact metrics this year.

USTAR Needs to Strengthen Its Outcome Collection and Reporting Process

As previously mentioned, we completed a follow-up review of USTAR last year that included an assessment of the initiative's fiscal year 2014 performance metrics. During that review, we found that USTAR lacked a rigorous process that could ensure accurate and

reliable reporting of outcomes. In that report, we recommended that USTAR formalize its metric reporting requirements by:

- Clearly defining metric definitions and count methodologies
- Implementing required reporting forms and formats
- Enacting required reporting time frames
- Requiring its partners to provide access to source documentation

USTAR needs to strengthen and formalize its process for outcome metric reporting.

During this review of USTAR's fiscal year 2015 annual report, we found that the prior recommendation has been partially implemented and the initiative still requires improvements to its annual reporting process. Thus, at the end of this report, we reiterate last year's recommendation that improvements in outcome reporting are needed.

For example, USTAR reports that it still encounters significant difficulties gaining access to source documentation of performance metrics. We had hoped that, over the past year, USTAR and its partners would have developed an efficient process to share metric source documentation for performance metrics. However, in its fiscal year 2015 annual report, USTAR indicated continued difficulty obtaining source documentation from its research university partners. Specifically, USTAR management stated the following:

USTAR reports continued difficulty gaining access to source documentation from its partners.

> USTAR does not have the authority or the access to the university systems to collect and validate data related to both commercialization related expenses and IP [intellectual property] license agreements, human resources information … and funding information … USTAR can request the information and reference documentation from the universities, but we cannot validate the information.

We are concerned with the continued difficulty USTAR faces in gaining access to source documentation from its partners. We do not expect USTAR to be the central repository for all research university or outreach program source documentation for the summary performance metrics it includes in its annual report. However, we believe the initiative's difficulty in obtaining requested source documentation from its partners, as part of the continued lack of a formal reporting process, complicates the preparation of its annual report and its subsequent annual external audit. We recommend that the Legislature consider clarifying USTAR's statutory authority to

access or obtain information and documentation from its partners in higher education for the purpose of reviewing and validating reported outcomes.

USTAR's current annual audit method involves presenting external auditors with summaries of reported performance metrics and requiring the external auditor to obtain source documentation directly from the research universities to validate metric accuracy. We believe this process is inefficient and limits the ability of the external auditor to conduct a timely review of USTAR's annual report.

Instead, we believe USTAR's internal auditor should develop a routine audit process that collects and reviews a sample of source documentation for the summary performance metrics it intends to include in its annual report. This testing process should be conducted throughout the year. This step would accelerate an external auditor's annual review process by allowing for an expedited test of the source documentation previously collected and the validation work previously performed by USTAR's internal audit function.

USTAR's internal auditor should develop a routine process to review a sample of outcome metric source documentation.

Research University Commercialization Metrics Are Incomplete and Economic Impacts Unavailable

Our review of USTAR's fiscal year 2015 annual report found that commercialization metrics are incomplete because USTAR has yet to finalize a full listing of technology license agreements and a complete understanding of agreement terms. USTAR states that the research universities have not agreed on such metrics. We believe this is a symptom of USTAR not yet completing our recommendation to implement a formal reporting process for its partners. Also, USTAR continues to be in negotiations with the research universities regarding when the initiative should be compensated for indirect benefits to non-USTAR researchers. In addition, USTAR did include early commercialization metrics in its annual report, but we noted some accuracy issues during our limited testing of the statistics. Lastly, USTAR staff stated that economic impact estimates are unavailable again this year because university partners did not provide the necessary data.

USTAR's Reporting of Commercialization Revenue Is Incomplete

Agreements that license university technologies to third parties are an avenue through which commercialization revenue is generated on those technologies. USTAR deems these license agreements to be a metric of U of U and USU commercialization progress. USTAR is required by statute to include in its annual report an accounting of commercialization revenue generated under such agreements. However, during our review, we found that a monetary accounting of commercialization revenues in addition to percent share estimates for commercialization potential are unavailable. USTAR states this is due to its inability to gain access to license agreements from university partners.

An accounting of commercialization revenue is unavailable as USTAR reports difficulty accessing university license agreements.

A Complete List of Active Licensing Agreements Is Unavailable. USTAR staff indicated that the universities have not provided a full accounting of commercialization revenue and expenses associated with individual licenses for the 2015 fiscal year. They stated to us that while they have been working this past year with the U of U and USU to gather a full listing of active license agreements (old and new) associated with the USTAR initiative, they question the completeness of their current listing due to access limitations.

In addition to annually reporting actual commercialization revenues in dollar terms, statute requires USTAR to report a list of intellectual property assets generated through the initiative; "…including a reasonable estimate of the USTAR initiative's percentage share of potential commercialization revenue…." USTAR staff stated they do not believe it is possible to estimate a percentage share of commercialization potential. Staff stated they are in the process of hiring outside counsel with expertise in intellectual property to help them summarize the complex terms of the license agreements from the research universities.

We believe an accounting of license agreements is foundational for USTAR to protect the state's interests and that USTAR should expedite the completion of this work with the full cooperation of the universities.

Thus, because of the currently unreliable listing of license agreements and the continued work needed to fully understand agreement terms, USTAR believes it is premature to attempt a monetary accounting of commercialization outcomes for fiscal year 2015. We believe a clear accounting and understanding of license agreements is a foundational element for USTAR to protect the state's interest in the initiative's activities. We believe USTAR should

expedite the completion of this work with the full cooperation of the research universities.

Negotiations Concerning Indirect Benefits to Non-USTAR Faculty Are Ongoing. In addition to commercialization revenues generated through license agreements of technologies created by USTAR-funded researchers, it is possible that non-USTAR-funded university researchers will produce some commercialization revenue for USTAR. This can occur when a non-USTAR-funded researcher receives an indirect benefit from the USTAR program by receiving services or access to USTAR-owned university facilities and equipment. However, in its fiscal year 2015 annual report, USTAR indicated that the terms for commercialization revenue sharing from indirect benefits to faculty are still being negotiated. USTAR's annual report states the following:

> Negotiations are ongoing since March between USTAR and the two research universities to define what constitutes "material support" from USTAR and therefore qualify the IP [intellectual property] generated for a return on the revenue to the state.

USTAR stated to us that finalized memoranda of agreements were provided to the two research universities during June and July of 2015 but the universities have not yet executed the documents. USTAR also reports it has withheld all payments in fiscal year 2016 to the research universities pending execution of these agreements and data reporting. We are concerned that after nine months of negotiations, USTAR and the research universities have not yet been able to come to an understanding on this issue. We recommend that USTAR and the research universities complete these negotiations so that a clear understanding is reached on when indirect benefits to non-USTAR researchers qualifies USTAR for a share in potential commercialization revenues from the related research work.

We are concerned that after nine months, USTAR is still in negotiations with research universities regarding indirect benefits to non-USTAR faculty.

We Noted a Few Errors During Our Limited Testing Of USTAR's Early Commercialization Metrics

For the 2015 reporting fiscal year, USTAR included a set of what we call early commercialization metrics in its annual report. These metrics are reported for USTAR-funded researchers. They include outside funding, invention disclosures, patents filed, patents issued, and technology license agreements. Figure 1 shows the early

commercialization outcomes that USTAR included in its annual report.

Figure 1 Research University Early Commercialization Metrics for Fiscal Year 2015. In its annual report, USTAR provided an accounting of early commercialization outcomes from USTAR-funded university researchers.

Institution	Outside Funding	Invention Disclosures FY15	Patents Filed FY15	Patents Issued FY15	Active License Agreements Entered into in FY15
University of Utah	$23,836,935*	27	36	6	4
Utah State University	$8,617,815**	8	35	3	6

Source: USTAR's fiscal year 2015 annual report
** FY 2015 totals for each USTAR researcher*
*** Expenditures in FY 2015 for all grant activity from a USTAR researcher*

As previously mentioned, USTAR management did not receive source documentation from the U of U and USU along with summary early commercialization statistics. Therefore, we provided USTAR with a small sample of the summary statistics for which we wanted source documentation to review. The results of this review process are discussed in the next five subsections.

We again found inconsistent reporting methods for the outside funding metric from the U of U and USU.

Outside Funding Reported By the Universities Is Still Inconsistent. During our fiscal year 2014 review of USTAR, we noted inconsistent university reporting methods for outside funding awards. Specifically, the U of U reported awards by annual installments while USU reported awards by total award value.

This year's reporting for fiscal year 2015 shows some improvement in outside funding reporting, but we again noted inconsistent reporting methods. Specifically, the U of U again reported awards by annual installments, but USU reported the awards by annual expenditures on the awarded funds.

We consulted USTAR staff to learn the correct reporting method and were told that USTAR had instructed universities for fiscal year 2015 to report outside funding awards by the annual expenditures on those awards. By this criteria, USU reported the awards correctly

while the U of U did not. However, when asked for the source documentation needed to validate USU's expenditures on the awards, the university's expenditure documentation was not readily available for our review.

We Successfully Validated a Sample of Reported Invention Disclosures. From USTAR's invention disclosures reported for fiscal year 2015, we took a limited sample and requested university source documentation. All seven invention disclosures we reviewed were successfully validated by U of U and USU-provided source documentation.

We successfully validated a sample of seven invention disclosures with university source documentation.

Patents Filed Needs an Explicit Count Methodology. From USTAR's reported patents filed for fiscal year 2015, we took a limited sample and requested university source documentation. Of the patents filed from the U of U, three of the four sampled were successfully validated with source documentation. Source documentation for one patent filed did not include a cover page like the others that records important information such as the filing date to ensure it is reported in the correct fiscal year. Of the patents filed from USU, we were able to validate all four in our sample with university source documentation. However, we noted that some filed patents were for the same technology but that they were filed in multiple countries.

For example, USU's Wave technology with the same tech identification number is listed as being filed for patents in Brazil, Mexico, the European Union, Korea, Japan, and China. This may explain why USU reports count of patents filed similar to the U of U's count, even though USU reports fewer disclosures, as shown in Figure 1. Overall, while USU reports 35 total patents filed during the 2015 fiscal year, the number would be only 19 patents filed if all the duplicate technology identification numbers were removed.

Therefore, is it appropriate to count a single technology multiple times if it is patented in multiple countries? Or should such instances be treated as a duplication of counts? USTAR staff indicated that initiative management did not explicitly define how to count the same technology patented multiple times in different countries. However, USTAR stated that the patenting of a technology in different patent jurisdictions is an indication of the commercial potential and should be counted as independent. This count methodology should be explicitly defined in USTAR's metric count policies and procedures.

USTAR should explicitly define the appropriate count method for patents filed in multiple countries.

We Successfully Validated All Reported Patents Issued. We were able to review all patents issued as disclosed in USTAR's fiscal year 2015 annual report because the documentation was available online. We independently validated all nine reported patents issued to the U of U and USU by utilizing the United States Patent and Trademark Office's website. However, in the future, if some patents reported are issued by countries other than the United States, we would likely need to rely on university source documentation to validate their existence if internet documentation is unavailable.

Two Errors Were Made in the Count of Active License Agreements. As mentioned previously, a complete count of all university license agreements related to USTAR is still in process. However, USTAR elected to report a count of active license agreements deemed new in fiscal year 2015. With university source documentation, we confirmed that the three U of U agreements in our sample were new in fiscal year 2015. However, two of the three USU agreements in our sample did not originate in fiscal year 2015; one of which had actually expired. We believe an error was made in counting USU's new licenses agreements for fiscal year 2015 and USTAR did not fully clarify the count during the limited timeframe for our review.

Our sample showed two errors were made in the USU count of new active license agreements.

USTAR's Economic Impact Estimates for The Research Universities Are Unavailable

USTAR reports that economic impact estimates from the research universities are unavailable again this year.

To address prior audit concerns about the reporting of the initiative's estimated economic impacts, USTAR hired a consultant during the 2015 fiscal year to develop a new survey methodology to gather information on such impacts. However, during our review of USTAR's fiscal year 2015 annual report, initiative staff indicated that the results of the research university survey were incomplete at the time of completion of the annual report. This means that accurate economic impact metrics such as new jobs created and state tax revenue are not available from research university reporting again this year. USTAR staff stated to us they understand the importance of capturing this information and have developed a methodology to collect and report it in future years. However, we recommend that USTAR complete the implementation of a process that is able to annually produce accurate economic impact estimates for its research university activities and that the universities cooperate with USTAR in providing the necessary information.

Outreach Economic Impact Outcomes Rely on Self-Reported Data

While economic impacts for the research universities were unavailable this year, USTAR included such outcomes for its outreach program in its fiscal year 2015 annual report, which were collected through a new client survey process. USTAR reports that such a methodology to estimate economic impacts is an industry best practice. We note, along with USTAR's consultant, that risks for survey bias are inherent in a self-reported survey. We credit USTAR and its consultant for responding to those risks by not projecting reported outcomes onto the portion of the initiative's clients that did not respond to the survey. We conducted a limited sample of survey responses from outreach program clients and noted that some survey respondents report difficulty in estimating the influence of USTAR in their successes, which can lead to changes in answers. We also noted an instance of survey response bias.

USTAR Implemented a New Survey Process To Estimate Outreach Economic Impact

As previously mentioned, to address prior audit concerns regarding the reporting of estimated economic impacts of the initiative, USTAR hired a consultant during the 2015 fiscal year to develop a new methodology. The process consists of conducting an online survey of individuals and entities that received some level of USTAR support through the outreach centers (funding or non-monetary assistance) and then using the responses to estimate economic impacts. USTAR stated to us that such a methodology is an industry best practice for economic impact reporting. Figure 2 shows USTAR's reported estimated economic impacts for its outreach program for the 2015 fiscal year.

During fiscal year 2015, USTAR hired a consultant to develop a survey method to estimate economic impacts for the outreach program.

Figure 2 USTAR's Estimated Economic Impacts for Its Outreach Program in Fiscal Year 2015. In its annual report, USTAR provided statistics across these six economic impact measures.

Economic Impact Metric	Reported Impact
Total follow-on investment	$26 million
2015 sales from a recently commercialized product or service	$6 million
Full-time and part-time employees	51 full-time, 63 part-time
High-quality jobs	14 full-time
2015 wages	$5 million
2015 tax revenue	$0.5 million

Source: USTAR's fiscal year 2015 annual report

The survey questions that produced the metrics in Figure 2 attempt to capture the respondents' views of the extent to which USTAR contributed to their success in securing new funding (referred to as follow-on investment), hiring employees, and selling their products or services. See Appendix A for a complete listing of the current survey questions that were provided to outreach program clients by USTAR's consultant.

USTAR Took Steps to Limit Survey-Response Bias Inherent In Self-Reported Survey Data

In addition to the actual outreach survey response data, USTAR's consultant also provided us with a copy of their written report titled *Measuring the Impact of USTAR's Technology Outreach Innovation Program: Baseline Impact and Methodology, August 14, 2015*. While we did not validate every aspect of it or all calculations in the consultant's report because of time constraints, we conducted a limited test of the survey response data to help us assess the new methodology's relative strengths and weaknesses.

One important thing to point out regarding the survey is that as it is primarily conducted through an internet survey tool, it requires respondents to self-type estimated performance outcomes. Specifically, 88 of the 94 survey respondents completed the survey over the internet, while the remaining 6 respondents' answers were obtained over the phone by USTAR's consultant. The online, self-reported nature of the survey reduces concern that outside bias was injected into the process.

However, other concerns of bias remain based on the very nature of data collected through a self-reported survey. USTAR's consultant rightly acknowledges such concerns in their report, saying:

> Achieving credible impact estimates from a survey can be challenging given the likelihood of survey response bias. For example, those companies that perceive they benefited more from their participation in the program may be more likely to take the time to respond to the survey, or it may be that more successful companies are less likely to respond because they are busier.

USTAR took steps to limit survey-response bias from data collected through self-reported surveys.

In response to such known potential survey biases, we credit USTAR and the consultant in choosing a conservative estimate approach that does not project the reported outcomes beyond its 25 percent survey response rate. Specifically, impacts are estimated only from direct survey responses instead of also extrapolating the reported impacts to the portion of USTAR's clients that did not respond to the survey. We also credit the consultant for including their analysis methodologies in their report which enhances overall reporting transparency.

In response to survey-bias risks, USTAR's consultant utilized a conservative direct-estimate methodology.

Our Limited Sample of Outreach Survey Responses Identified Some Concerns

While we are encouraged by the work of USTAR's consultant and note that the vast majority of survey responses come directly from outreach clients, we attempted to contact eleven respondents by phone to validate their answers and successfully held discussions with six of them. This test revealed two issues, of unknown magnitude, that should be considered regarding the nature of information obtained through surveys of USTAR's clients. These two issues are addressed in the next two subsections.

Respondents Report Difficulty Estimating USTAR's Contributions to Their Successes. During our phone conversations with six outreach program survey respondents, we reviewed their reported answers with them, including questions concerning:

- Follow-on funding received after assistance from USTAR
- Annual product or service sales following help from USTAR
- The number of jobs created due to USTAR (full-time and part-time)
- The average annual salary of those jobs

While most individuals we contacted confirmed their answers to the survey questions, we repeatedly were told that it was very difficult for them to quantify the share of their success that should be reported as attributable to USTAR's assistance; especially when the assistance was not financial in nature. Instead, they simply were able to provide a best guess of the follow-on funding they have received or the employees they have hired that are related to the help they have been given through USTAR's outreach centers.

One respondent contacted was unable to confirm his/her prior survey answer.

These best guesses can lead to changing answers if further review is conducted. For example, one individual we contacted that originally reported two-full time and two part-time employees hired due to USTAR's help, said he/she would now only report the two part-time employees if asked today. This person indicated he/she is unclear about his/her thought process when they originally reported, a few months prior, the two full-time jobs created.

A Desire to Report Positive Impacts from USTAR's Contributions Can Bias Respondent Answers. While the potential for survey response bias was previously mentioned in this report, this specific example is important to note. During our review of USTAR's outreach survey responses, we encountered an instance where a reported outcome appeared to not have been attributable to USTAR.

One respondent credited USTAR with outcomes achieved before starting a relationship with the initiative.

An individual responded during the survey that follow-on funding had been received but also commented that it was received before beginning a relationship with USTAR. We contacted this individual and confirmed that the outside funding was not actually received in conjunction with USTAR's help. While we understand the individual's desire to praise USTAR for the subsequent assistance that he/she finds valuable, we do not believe it is accurate to report non-USTAR-related outcomes as USTAR-caused impacts.

Recommendations

1. We recommend that USTAR continue to strengthen its formal metric reporting requirements in administrative rule or contracts with funding recipients by fully implementing:

    a. Clear definitions and count methodologies of metrics

    b. Required reporting forms and formats

    c. Required reporting time frames

    d. Required access to source documentation

2. We recommend that the Legislature consider clarifying USTAR's statutory authority to access or obtain information and documentation from its partners in higher education for the purpose of reviewing and validating reported outcomes.

3. We recommend that USTAR's internal auditor develop a routine audit process to assess the validity of summary outcomes reported by the initiative's partners by collecting and reviewing a sample of source documentation throughout the year.

4. We recommend that USTAR continue to improve its process to monitor active technology license agreements to ensure that counts are accurate and terms are understood so that commercialization revenue accounting and percent share estimates can be included in the initiative's annual report.

5. We recommend that USTAR continue to work with the research universities to complete negotiations concerning when indirect benefits to non-USTAR researchers qualify USTAR for a share in commercialization revenues from the related research work.

6. We recommend that USTAR make explicit its methodology for intellectual property assets that may trigger a duplicate count, such as when a single technology is patented in multiple countries.

7. We recommend that USTAR complete the implementation of a process that is able to annually produce accurate economic impact estimates for its research university activities.

Appendix A

USTAR Technology Outreach Innovation Program (TOIP) Client Company Survey

Introduction

You have received this survey because you (or your company) have received assistance from USTAR's Technology Outreach Innovation Program (TOIP) in the last few years. SRI International, a not-for-profit research center, is conducting this survey as part of an independent study to evaluate the impacts of the TOIP program to comply with legislative reporting requirements. Your input will help us to better understand how the program impacts client companies like yours.

- This survey is short, with only 10 questions, and should take 5-10 minutes of your time to complete.

- Your responses to this survey are confidential.

- Your Survey is only accessible through the unique web address that you were given.

- Survey results will be analyzed and reported only in the aggregate: for example, "On average, TOIP client companies reported $XX of follow-on investment."

Your participation in this survey is voluntary. No personal information will be collected and no one will be identified in any published reports. By continuing with this survey you are giving your consent.

Thank you!

About Your Company and Assistance Received

* **1. Please select the USTAR TOIP Centers with which you have interacted and/or received services.**
Check any that apply

- ☐ USTAR North (Farmington, Weber State University)
- ☐ USTAR East/Energy (EGI at U of U and BEERC & CEIC at USU)
- ☐ USTAR South (St. George)
- ☐ USTAR Central (Orem)
- ☐ SBIR-STTR Assistance Center (Sandy)
- ☐ BioInnovations Gateway (South Salt Lake)

* **2. Did your Utah-based company receive its Employer Identification Number (Tax Identification Number) during or after receiving services from USTAR TOIP?**

◉ Yes ○ No

* **2a. Was USTAR TOIP assistance critical to establishing your company?**

○ Yes ○ No

3. Does your company license technology from any of the following?
Check any that apply

- ☐ Company
- ☐ University
- ☐ Government
- ☐ None

* **4. In what year(s) did your company receive services from USTAR TOIP?**
Check any that apply

- ☐ 2015
- ☐ 2014
- ☐ 2013

- ☐ 2012
- ☐ 2011
- ☐ 2010
- ☐ 2009
- ☐ 2008
- ☐ Never received assistance from USTAR TOIP

5. What type of assistance did you receive from USTAR TOIP?

Investment Capital Assistance (check any that apply)**:**

- ☐ Go-To-Market funding
- ☐ GOED Technology Commercialization Innovation Program funding
- ☐ Technology Commercialization Grants (2009-2011 only)
- ☐ Assistance identifying a potential funding source
- ☐ Assistance preparing an SBIR/STTR proposal
- ☐ Investor pitch preparation

Business Assistance (check any that apply)**:**

- ☐ Entrepreneurship training (e.g., Lean Launchpad, Nail It then Scale It, NEXT)
- ☐ Business coaching or mentoring
- ☐ Network of professional contacts
- ☐ Connection to student interns (e.g., high school, college, etc.)
- ☐ Mentoring or assistance from other client companies

Technical Assistance (check any that apply)**:**

- ☐ Access to equipment, laboratory, clean room, office or meeting space, etc.
- ☐ Prototyping or design assistance
- ☐ Network of professional contacts (e.g., subject matter experts)
- ☐ Assistance protecting intellectual property

Other (please specify)

Financing

* **6. Do you think USTAR services (including financial assistance) contributed to your company's ability to obtain non-USTAR funding?**

◉ Yes ○ No

6a. Please indicate the amount of non-USTAR funding received by your company.

Commercial lending institutions – Amount ($):	
Private investors (e.g., angel investors) – Amount ($):	
Strategic partners (other companies, etc.) – Amount ($):	
Institutionally managed venture capital - Amount ($):	

Federal SBIR/STTR award – Amount ($):

Other Federal grants or contracts – Amount ($):

Other Utah programs – Amount ($):

Other (please describe) – Amount ($):

Innovation

* **7. Do you think USTAR services (including financial assistance) contributed to your company's ability to introduce any new products or services into the marketplace?**

◉ Yes ○ No

7a. Please provide a date and description for these products or services.

7b. What are your total annual sales from these products or services? ($)

Employment

8a. Please provide the current number of employees at your company.
Only numbers may be entered in these fields.

Full-time employees

Part-time employees, including consultants

Interns

8b. Do you think USTAR services (including financial assistance) contributed to your company's ability to hire some or all of these employees? If yes, how many?
Only numbers may be entered in these fields.

Full-time employees

Part-time employees, including consultants

8c. What is the average annual salary of the employees identified in 8b?
Only numbers may be entered in these fields.

Full-time employees - Average Salary ($):

Part-time employees, including consultants - Average Salary ($):

Revenue

9. Please provide total annual revenue for your company.
Choose one of the following answers

Please choose...

Comments

10. Please provide any specific comments or suggestions you have regarding any aspect of your interaction with USTAR TOIP, including any changes USTAR could make to better meet your needs in the future.

Load unfinished survey

Resume later

Submit

Exit and clear survey

- 24 -

USTAR RESPONSE TO AUDIT

Agency Response

January 11, 2016

John Schaff, Auditor General
Office of the Legislative Auditor General
State of Utah
W315 Utah State Capitol Complex, PO Box 145315
Salt Lake City, UT 84114-5315

Dear Mr. Schaff,

The Utah Science Technology and Research (USTAR) Governing Authority (GA) appreciates the opportunity to respond to the audit entitled **USTAR ANNUAL REVIEW: PERFORMANCE OUTCOME REPORTING REMAINS UNDER DEVELOPMENT** (Report No. ILR2016-A). This audit recognizes the progress that USTAR has made in meeting the statutory reporting requirements for its annual report and the challenges that remain in identifying, collecting and validating the data from USTAR partners and companies served by USTAR.

The USTAR GA is resolutely committed to providing transparency, accountability and responsibility to the citizens of Utah through accurate and reliable outcome and fiscal reporting. Over the past 18 months USTAR has implemented extensive changes in governing practices, policies, organizational structure and staff. In addition, it has worked aggressively to align its practices and procedures to industry best practices. To this end, USTAR hired an independent, internationally-recognized consultant, SRI International, to conduct a thorough and extensive study of the Utah technology ecosystem to identify gaps, and make recommends for programmatic changes to address these gaps and to conduct an extensive examination of best practices for measuring the economic impact of science and technology economic development programs for USTAR.

Based on this study, USTAR is working with members of the Legislature and executive branch staff to (1) ensure the programs, metrics and reporting for USTAR are designed and implemented to fill its mission to stimulate invention and development and sale of technology in the market gaps in Utah's technology economy and (2) ensure that statutorily-required metrics are measurable and meaningful. We appreciate the support of the Legislature in engaging with USTAR to address these challenges by, among other things, amending USTAR's governing statutes.

USTAR responds to the specific recommendations of the audit in the following pages. We look forward to responding to additional questions and suggestions as the audit is presented to legislative committees.

Sincerely,

Greg Bell, Chairman
USTAR Governing Authority

<u>USTAR responses to specific audit recommendations</u>

1. ***We recommend that USTAR continue to strengthen and formalize metric reporting requirements in administrative rule or contracts with funding recipients by fully implementing:***
   - ***Clear definitions and count methodologies of metrics***
   - ***Required forms and formats***
   - ***Required reporting time frames***
   - ***Required access to source documentations***

USTAR agrees with the importance of establishing formalized metrics and reporting requirements and believes that it has demonstrated a commitment to implementing a rigorous reporting process by its actions in the past year. Specific examples of USTAR's efforts include:

a. Completing a comprehensive review of statutory reporting requirements with the research universities.
b. Providing definitions of terms relevant to USTAR's transactions with comprehensive reporting forms for the research universities.
c. Executing new contracts that require university partners to provide statutorily required metrics.
d. Requiring ongoing reporting by contract.

e. Making initial highly specific requests for annual report data several months prior to the audit.
f. Hiring an independent third-party (SRI) to assist in collecting and evaluating key performance metrics, which resulted in a comprehensive written evaluation, report and recommendations.
g. Engaging a company to develop a database to collect and store university reported data.
h. Providing input and feedback to the Legislature for future legislation to clarify the reporting responsibilities of USTAR and its stakeholders.

USTAR will continue to work diligently to ensure audit recommendations are fully implemented as the agency works to develop a metric reporting process that fulfills statutory requirements, is consistent with industry best practices, and provides accurate and useful information to the Legislature and the public.

2. ***We recommend that the Legislature consider clarifying USTAR's statutory authority to access or obtain information and documentation from its partners in higher education for the purpose of reviewing and validating reported outcomes.***

USTAR appreciates the recommendation for the Legislature to consider clarifying USTAR's authority to obtain and validate information from its partners in higher education.

3. ***We recommend that USTAR's internal auditor develop a routine audit process to assess the validity of summary outcomes reported by the initiative's partners by collecting and reviewing a sample of source documentation throughout the year.***

USTAR agrees that it is necessary to establish a routine audit process to verify information reported by agency partners. USTAR also agrees that a fundamental component of the audit process involves reviewing samples of source documentation to verify reported data throughout the year. To this end, USTAR has taken the following steps that it believes will enable the agency to fully implement this recommendation:

a. Worked with a third-party consultant (SRI) to evaluate and determine best practices for reporting outcome metrics that are auditable and verifiable (see letter from SRI).
b. Executed contracts with new terms requiring university partners to provide routine reporting of and to certify the accuracy of reported data, and maintain auditable supporting documentation of all reported information.
c. Implemented a new budget process that requires all expenditures invoiced by initiative partners to be reconciled with source documentation prior to reimbursement.
d. Engaged a company to develop a database which will be used to collect and store reported data and source documentation, enabling validation to be done in real time.

USTAR is committed to continuing to improve its internal audit processes and will ensure processes are in place to appropriately validate reported information

4. ***We recommend that USTAR continue to improve its process to monitor active technology license agreements to ensure that counts are accurate and terms are understood so that commercialization revenue accounting and percent share estimates can be included in the initiative's annual report.***

USTAR agrees with the Auditor's recommendation and that it is important to continue monitoring all active licensing agreements and to ensure the terms of such agreements are understood and accurately reported. USTAR has taken significant actions along these lines including the following:

a. Where possible, collected and reviewed licensing agreements provided by the research universities.
b. Hired an independent third-party (SRI) to conduct a survey of licensees and produce an impact assessment.
c. Worked with the Attorney General's office to hire an intellectual property attorney who will assist in reviewing licensing agreements.
d. Formed a commercialization sub-committee of the USTAR Governing Authority to perform periodic in-depth reviews of licensing agreements.

USTAR will continue to collect information on for all licensing agreement entered into in connection with USTAR related technology.

5. ***We recommend that USTAR continue to work with the research universities to complete negotiations concerning when indirect benefits to non-USTAR researchers qualify USTAR for a share in commercialization revenues from the related research work.***

USTAR agrees that it is important to come to an agreement on what rights USTAR has regarding commercialization revenue attributable to non-USTAR researchers. As the Audit points out, in June and July of 2015, USTAR provided the research universities with proposed Memoranda of Agreement, drafted by the Utah Attorney General's office, addressing the concerns underlying this recommendation. Since the conclusion of the audit, Utah State University has signed the Memoranda of Agreement. USTAR will continue to work closely with the research universities and legislature to ensure that the Legislative intent behind the formation of USTAR can be fulfilled.

6. ***We recommend that USTAR make explicit its methodology for intellectual property assets that may trigger a duplicate count, such as when a single technology is patented in multiple countries.***

USTAR agrees that methods for collecting and reporting metrics related to intellectual property assets should be designed in such a way as to minimize the risk of using an over-inclusive count methodology that could result in reporting imprecise performance metrics.

Regarding the issue of a "single technology" that is patented in multiple countries, it is important to note that the statute does not provide guidance on how to address this issue.

For this reason USTAR, and as noted in the audit report, for the FY2015 annual report *USTAR chose to employ a count methodology whereby each patent filed was counted once as one filed patent*. USTAR believes this is a reasonable interpretation of the statute and that by providing the raw data in the annual report, any potential confusion about the meaning of the reported metric has been reasonably mitigated.

7. ***We recommend that USTAR complete the implementation of a process that is able to annually produce accurate economic impact estimates for its research university activities.***

In response to the second paragraph of the Annual Review (page 1) and other references to "incomplete" economic impact metrics for the universities, USTAR is concerned that the Office of Legislative Auditor General is holding USTAR to a higher standard than the Legislature requires. Utah Code § 63M-2-401(2)(f)&(i) states:

> (2) *For each project, operation, activity, program, or service related to the USTAR initiative or overseen or funded through the USTAR governing authority*, the annual report shall include: . . .
>
> (f) the number of jobs and the corresponding salary ranges created by the USTAR initiative, including the number of jobs where the employee is expected to be employed for at least one year and earns at least 125% of the prevailing wage of the county where the employee works;
>
> . . .
>
> (i) the tax revenue generated as a result of the USTAR initiative, with actual revenue generated clearly separated from potential revenue;
>
> Utah Code § 63M-2-401(2)(f)&(i) (emphasis added).

In consultation with counsel from the Attorney General's Office, USTAR determined that the agency functions described in subsection (2) do not include so-called "spin out" companies that license university intellectual property ("IP"). USTAR takes this position for a number of legal and pragmatic reasons.

First, such companies are completely separate from USTAR: they come into existence and develop independently. They subsequently opt to license particular technologies from the Research Universities. The only nexus to USTAR is that, in some cases, these licensed technologies were developed, in whole or in part, by USTAR researchers, with USTAR funds and/or at USTAR facilities. Thus, spin-out companies themselves are not part of a USTAR-administered "project, operation, activity, program, or service."

USTAR's connection can be great to very small, and thus accurate tracking becomes impossible. The Legislature understood this when drafting the statute as shown by their use of the phraseology "overseen or funded" as a catch-all for any other USTAR-related functions not otherwise listed. In this case, spin-out companies are not overseen by USTAR as USTAR is not a party to the licensing agreements governing their use of university IP (the two-party agreements are between the university and the company). In addition to lacking legal authority to require the companies to provide data regarding jobs and tax revenues, USTAR lacks statutory authority to independently access their tax information through State databases. Furthermore, the spin-out companies are not funded by USTAR; rather, the companies themselves pay to use USTAR IP. Finally, even if the companies were willing to voluntarily provide the data, USTAR would be unable to validate it, making the efforts to collect both impracticable and inefficient.

For these reasons, in the 2015 Annual Report, USTAR outlined its position as follows:

> *Jobs created by the USTAR initiative include [those] created by USTAR directly funding positions, those created at the Universities paid for by USTAR funding or by federal funding received by USTAR researchers and jobs created by companies that worked with the USTAR outreach program. USTAR can only validate data for USTAR employees and the amounts paid by USTAR to researchers at the universities.*
> . . .

In USTAR's interactions with the Office of Legislative Auditor General there has been some discussion about whether or not USTAR's interpretation aligns with the 2005 USTAR Prospectus projections. Since 2005, the USTAR statute has undergone multiple, significant organizational and statute changes. There is consensus that the 2005 prospectus was developed with assumptions that did not hold through the great recession. Additionally, current Utah Code defines the requirements for USTAR reporting and this differs significantly from the measures in the Prospectus.

In summary, USTAR believes that it has adopted the most reasonable interpretation of its statutory reporting obligations under Utah Code § 63M-2-401(2)(f)&(i).

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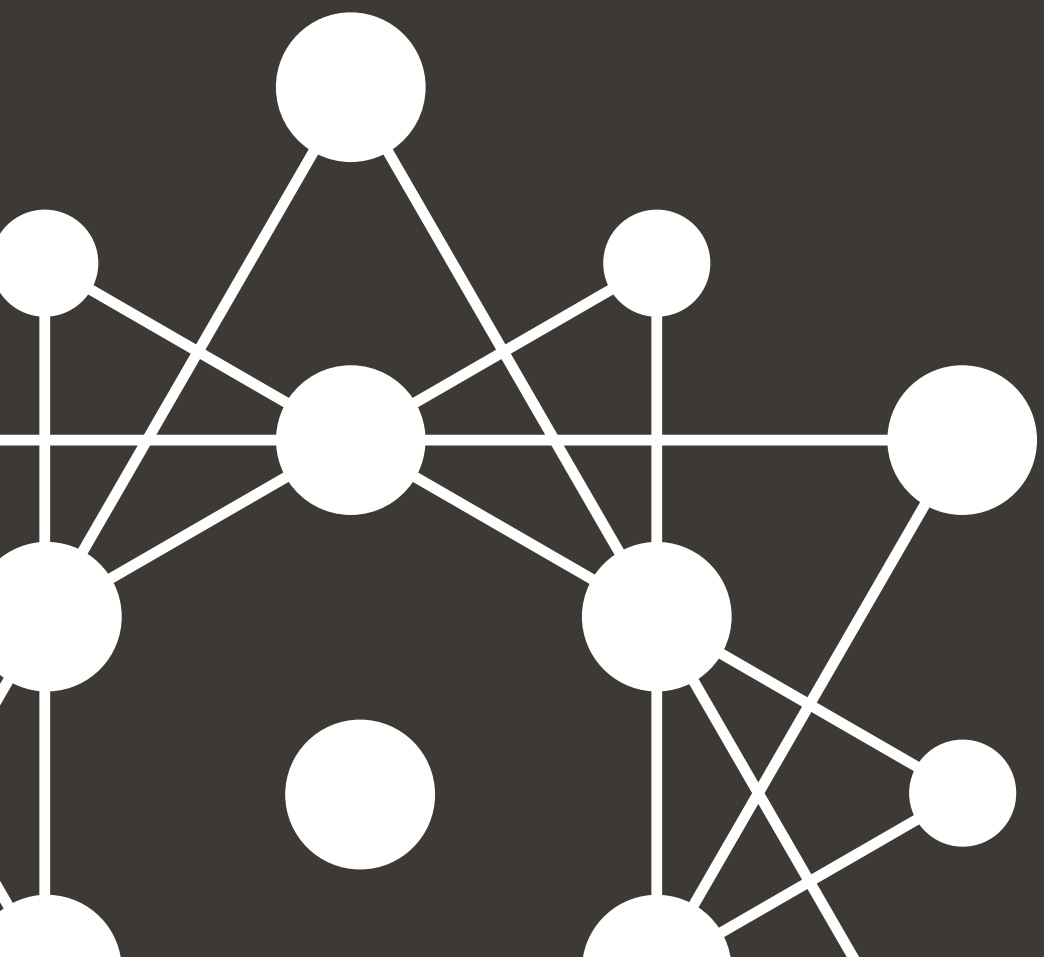

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