NSF Convergence Accelerator:
Industry-University Partnerships and the Future of Work
Listening Sessions Report

Strategy Session
University of Oxford
July 30, 2019

Listening Sessions

University of Central Florida	Case Western Reserve University
September 24, 2019	October 1, 2019

Dartmouth College	UC San Diego	University of Kansas
October 10, 2019	October 15, 2019	October 17, 2019

Culminating Conference
Bose & University of Massachusetts
November 13, 2019

Organizer
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University Industry Demonstration Partnership

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BACKGROUND

In May 2016, the National Science Foundation (NSF) unveiled 10 Big Ideas for Future NSF Investments (https://www.nsf.gov/about/congress/reports/nsf_big_ideas.pdf). One of NSF's 10 big ideas was **The Future of Work at the Human-Technology Frontier (FW-HTF)**.

In 2019, NSF created the Convergence Accelerator (C-Accel) program to speed up use-inspired, convergence research. With its unique program structure, C-Accel offers researchers and innovators the opportunity to accelerate their research toward tangible solutions that make a difference.

UIDP (uidp.org) is a global member association of large innovation companies and research universities that organized a series of listening events in 2019 to explore effective strategies for how the private sector can partner with academic institutions (and other relevant parties) to address questions raised by the NSF through its 10 Big Ideas FW-HTF effort while leveraging the C-Accel program.

Shortly after completion of the UIDP sessions in 2019, the nature of work was dramatically affected by the COVID-19 pandemic. Recognizing the need to address contemporary issues raised by the pandemic and how work would be performed, UIDP used a diverse set of approaches (surveys, webinars, and virtual listening sessions) to gain insights on the Future of Work.

RATIONALE

The UIDP events looked specifically at the C-Accel program and how it can be used to advance NSF goals around FW-HTF. The objective was to develop a deeper understanding of the FW-HTF research and commercialization opportunities realized through high-impact, academic-corporate collaborations and the C-Accel program by addressing:

- research topics which would be most fruitful for the C-Accel program to support;
- C-Accel methodologies to expand and enhance collaborations; and
- effective ways the C-Accel program can catalyze practical applications and use research results.

UIDP specializes in understanding university-industry collaborations. It develops tools to make partnerships more effective and efficient. UIDP understands that companies rarely make investments in early-stage basic research at universities. But they also know that industry often supports pre-competitive, use inspired research. Knowing this, UIDP offered the listening sessions as an efficient and affordable way to gather information for NSF as it considers future deployment of C-Accel resources.

PROCESS

UIDP surveyed its membership to gauge interest in FW-HTF, and there was a high level of enthusiasm. Shortly after, UIDP issued a request for information (RFI) and selected seven organizations and six sites from across the country to host these information gathering events.

The event series began with a strategy session at an international workshop at Oxford University in July 2019. This strategy session was followed by five listening sessions at locations across the United States in Fall 2019. The hosts (and number of attendees) of the five listening sessions were:

- The University of Central Florida (29)
- Case Western Reserve University (55)
- Dartmouth College (58)
- UC San Diego (42)
- The University of Kansas (63)

The series culminated in the two-day conference hosted by Bose and the University of Massachusetts System where representatives from each listening session—54 participants total—participated in a national dialogue about FW-HTF and the C-Accel program. The findings from these listening sessions and the resulting conference are presented in this report.

UIDP sought attendees who served in decision-level positions for their organizations. Academic researchers and industry representatives led the listening sessions. Participants included:

- Leading innovation firms and small-midsized companies: UIDP sought diverse representation from the firms' technical community, technical leadership (such as the Office of the CTO), and the university relations program. Invitees were expected to serve at a level that allowed them to make decisions on future investments on behalf of the company.
- Universities with strong research and industry engagement programs in the four areas covered by the Future of Work Big Idea: Typical representatives were research leadership (i.e., senior research officers and associate deans) and active researchers.
- Nonprofit organizations and independent groups that could contribute to the discussions;
- Principal investigators who were funded through NSF Future of Work initiatives; and
- Federal government representatives who attended as observers.

NSF had identified four topic areas related to the FW-HTF:

I. Building the human-technology partnership
II. Augmenting human performance
III. Illuminating the socio-technological landscape

IV.   Fostering lifelong learning

To ensure adequate time for discussion, each host location covered one or more of these four topic areas as the focus of their events.

NSF, partnering hosts, and leading technical experts developed similar agendas for each location. Besides sessions on specific FW-HTF topics, each university incorporated an NSF-led C-Accel session. The listening sessions assisted regional hosts in establishing localized research networks that focus on the FW-HTF.

NSF FTW-HT Research Theme		Building the Human-Technology Partnership	Augmenting Human Performance	Illuminating the Socio-Technological Landscape	Fostering Lifelong Learning
Location	Date				
University of Oxford Strategy Session	7/30/19	●	●	●	●
University of Central Florida	9/24/19	●	●		
Case Western Reserve University	10/1/19		●	●	
Dartmouth College	10/3/19	●		●	
UC San Diego	10/15/19		●	●	
University of Kansas	10/17/19				●
Bose/UMass	11/13/19	●	●	●	●

Table I. Schedule of Events

UIDP DELIVERABLES

- Produce a written report that identifies priority research and commercialization thrusts within the FW-HTF. These priorities and opportunities can be used to inform decisions on how to use the C-Accel program to achieve FW-HTF goals.
- Identify a cadre of individuals from distinct, complementary sectors who can be engaged in the future to consider progress and additional opportunities. The networks established by the geographically diverse listening sessions are the foundation for the collaborative partnerships that are necessary for the success of C-Accel projects.
- Elucidate program features that can catalyze C-Accel research into practical use.

This report captures the findings of the listening sessions in a concise summary and provides NSF with information about how to advance its FW-HTF goals. In addition, it highlights areas for strategic investments, topic areas for the C-Accel program to consider, and collaboration tools that can enhance the effectiveness and efficiency of the C-Accel program.

COVID-19 IMPACT

During the award period, COVID-19 dramatically altered the nature of work and university-industry interactions. The interruption affected the direction of this work and provided additional areas for study. This report captures UIDP's work in exploring how the pandemic affected future work plans and how universities and companies will interact as a result.

UIDP hosted seven calls to address challenges that arose from the need to shift from in-person meetings to remote collaboration approaches. The goal of these calls was to use a rapid response approach to crowdsource ideas and solutions.

Using the findings from these discussions, UIDP created a distinct report on how companies and universities adapted and what the industry-university partnership landscape looks like moving forward. This report references statistics and general findings from the discussion series, including statistics from electronic surveys sent to UIDP members, polling, or free-form responses provided during the discussions. While not scientific surveys, the report information should be interpreted as an aggregation of the views of those working for large companies and research universities during the height of the pandemic while under widespread isolation directives. This report contains pertinent findings from the COVID-19 work performed by UIDP from April through December 2020.

KEY HIGHLIGHTS FROM THE UNIVERSITY OF OXFORD SESSION

University of Oxford
July 30, 2019

Session: The Future of Work: Contemporary Matters and University Approaches

The Future of Work is receiving a tremendous amount of interest in academic, corporate, government, and non-profit sectors. This session provided an overview of the issues and how academia is seeking to respond to the opportunities and challenges posed by the Future of Work.

Session: Industry Interest in the Future of Work

Companies are assessing the impact of the future work trends on their businesses and considering ways to partner with universities on research trends.

Session: The U.S. NSF Big Idea on the Future of Work

The National Science Foundation has identified the Future of Work as one of its 10 Big Ideas. Presenters provided information on this initiative and how government agencies can support efforts.

Session: Thematic Tabletop Discussions

Tabletop discussions covered the topics of lifelong learning, geographical matters, diversity and inclusion, and industry engagement in R&D.

Session: Discussion, Takeaways, and Conclusion

The Future of Work is receiving unparalleled attention from the academic, corporate, and governmental sectors as well as the general public. While offering tremendous opportunities, there are significant challenges. Current and future workers are worried about myriad factors— globalization, technological progress, and demographic change—and their impact on society and labor markets. Partnerships between universities and companies offer an attractive approach to addressing these opportunities and challenges. Government agencies, like NSF, recognize the critical role that these collaborations can play and are establishing programs to support these endeavors.

Companies seek employees who are better prepared for the workplace, and they struggle with the need to provide intensive training upon hiring. The need for training is true for new employees who have just completed their formal educational studies – regardless of where they went to school.

KEY HIGHLIGHTS FROM LISTENING SESSION SITES

The University of Central Florida
September 24, 2019

KEYNOTE ADDRESS - Mary Czerwinski, Microsoft Research

Using Technology for Health, Wellbeing, and Empathy

The speaker highlighted trends in the Future of Work. These included people working with AI and robots, an aging workforce in need of technology training, crowdsourcing work, computer-assisted staffing, and creating fun workspaces.

Key Takeaways:

- We need to build empathetic cues into technology to replicate face-to-face encounters.

- Studies have found seven emotional cues across cultures. Scientists are incorporating these cues into technology.

- Researchers must take care when integrating negative emotions into technology. Always consider the diversity of communicators.

TOPIC: AUGMENTING HUMAN PERFORMANCE

Session: Augmenting Human Performance

The panelists highlighted best practices for training employees, the different ways technology is changing industry, the status of robot development, and the role of AI in decision-making.

Key Takeaways:

- In the future, AI can support research and learning by suggesting to people different ways to analyze the materials they are working on.

- Technology is changing healthcare, sensing in mining and drilling operations, and remote workplaces.

- Robots are still a work in progress. Researchers have not yet released them in uncaged, unstructured environments. Autonomous machines still depend on guidance and often a human monitoring or controlling them.

Session: Augmenting Human Performance

Participants discussed cybersecurity, changes in higher education, how universities and industry can work together to address workforce of the future opportunities and challenges, and how augmented reality and virtual reality will be accessible to the general public.

Key Takeaways:

- A university degree is a good foundation, but universities should also offer certificates of skills. Students could also do internships with corporate partners to clarify their interests.

- There are not enough university-industry partnerships, including for student internships and joint hires. Also, there should be curriculum alignment with industry needs.

- The widespread use of augmented reality (AR) and virtual reality (VR) will depend on cost. If people grow accustomed to AR and VR in their everyday lives, these technologies will also begin to appear in the workplace.

TOPIC: BUILDING THE HUMAN-TECHNOLOGY PARTNERSHIP

Session: Building the Human-Technology Partnership

Universities and industry are both changing due to advances in technology.

Key Takeaways:

- Instead of imparting knowledge, teachers now help students to refine understanding. This change has occurred because technology has allowed students to learn more outside of the classroom. This shift in teaching roles allows for more classroom discussion and active learning.

- A company is less likely to adopt new technology if it causes risk or a loss of profit.

- The rate of adoption of new technology may not correlate with the perceived economic status of the country. For instance, some less developed countries rapidly adopted cell phone technology.

Case Western Reserve University
October 1, 2019

Session: University-Industry Collaboration in the Context of the Future of Work

The panelists examined how university-industry partners can identify and advance research topics to yield the best results.

Key Takeaways:

- Jobs will not go away, but they will change. By 2030, 30% to 40% of workers in developed countries will learn new skills and/or change their occupations.

- Humankind will not become superfluous. Non-automated tasks will still need human attention and keeping humans at the center is critical for the successful adoption of technological innovations.

- Socio-emotional and higher cognitive skills, together with technological training, are the skills of the future.

TOPIC: AUGMENTING HUMAN PERFORMANCE

Session: The Role of Brain-Interfacing in Shaping the Future of Work

Participants discussed augmentation of human performance and perception, how to make access to technology fair, security and privacy concerns with monitoring of neural data for non-medical applications, ownership of a person's brain data, impacts of data quality and accuracy, implications of data corruption and biases, implications for human relationships, and the benefits of a tech+ approach, especially from a regulatory standpoint.

Key Takeaways:

- Researchers, scientists, and technologists need training in the transparent dissemination of the implications of their work.

- Universities need to require and reward interdisciplinary research.

- Companies must balance the economic advantages of technology versus worker autonomy.

Session: Impact of Robotics, Automation, and Intelligent Assistance Technologies on the Future of Work

This session explored advances in robotics and AI technologies and pervasive intelligent and autonomous systems. These technologies promise the creation of new industries and occupations, enhanced productivity, and quality of work life. They may also allow for more people to take part in the workforce. Potential challenges and impacts include jobs lost to automation, a mismatch between worker skills and skills required in new industries, security threats, algorithmic biases, and dependence on technology and the resulting erosion of human knowledge and skills.

 Key Takeaways:

- Desired outcomes from advancements with automation include efforts to ensure that individuals affected can find attractive alternatives and enjoy their replacement automation, a cultural shift to recognize this shift as a benefit, and a study on the improvement in quality of education utilizing modern approaches.

- Actionable steps include retraining human workers to collaborate with AI and determining metrics on what to automate.

Session: The Future of Learning: How We Train Workers and Use Technology

This session explored ideas, drivers, and risks of improving human learning and workplace performance through the use of technology. Participants mainly focused on augmented reality (AR) and virtual reality (VR). Combinations of technology like environmental sensors, wearables, and haptic gloves will alter how workers learn, perform, and interact. These technologies will enable quick worker learning and better workflow efficiencies.

Key Takeaways:

- Mixed reality (MR) is an opportunity to collaborate on a large scale and to influence policymakers.

- Researchers need to address the risks of using MR as a training tool. Potential problems include loss of human communication, technology overload, and misuse of data.

- If automation eliminates some low-skill jobs, we need to provide educational opportunities for all.

Session: NeuroReality and The Future of Work: Mind Transcending the Barriers of Body to Achieve the Full Human Potential

NeuroReality is the meaningful and ethical evolution of the connection between humans and technology. The technology enables the mind to transcend the physical barriers of the body to achieve full human potential. What this means for the Future of Work: "Anything, Anytime, Anyone, Any team, Anywhere."

Key Takeaways:

- NeuroReality presents an opportunity to enhance social connectivity and empathy, to distribute experience (not knowledge per se), to globalize communities, to create new business opportunities, and to separate individuals from harmful environments, such as when setting off explosives or cleaning up after a nuclear accident.

- Barriers to the adoption of NeuroReality include the perception that sacrifices may not be worth the value. Sacrifices might consist of implanting a device, financial costs, and privacy issues.

- Values gained might include more leisure time, simplicity, or safety.

TOPIC: ILLUMINATING THE SOCIO-TECHNOLOGICAL LANDSCAPE

Session: Thriving in the New Socio-Technological Landscape(s): Education and Employment

This session covered the national and global impacts of technological advancements on education and employment. Key issues discussed in the session included climate change, economic inequity, the skills gap between what universities are teaching and what employers need, and the role of government in the regulation of technology.

Key Takeaways:

- The lack of digital infrastructure is holding back digital benefits in both developing and developed economies.

- Routine skills are less needed in the job market now and in the future.

- Human skills such as empathy, creativity, and enthusiasm for learning will remain essential. Critical skills will also include the ability to embrace change and uncertainty.

Session: The Role of Artificial Intelligence Assistance on Human Skill in the Workforce

Participants considered whether repeated use of AI in the workplace causes skill atrophy. They also discussed whether the use of AI during training hinders learning.

Key Takeaways:

- Stakeholders should evaluate the need to make time to prevent the atrophy of certain skills.

- Two AI approaches may reach different conclusions because they are not as content- or context-sensitive as humans.

- AI assistants and whether they hinder a specific ability, such as remembering phone numbers or impede memorization in general, should be further explored.

- AI has a role as a way to reskill or remind ourselves of where we have atrophied.

Session: The Future of Farming and Feeding

This session focused on the interplay between the food supply chain and human health issues. The discussion focused on the role of food systems on human health and how technology might address chronic health issues. Other topics included narrowing the urban-rural divide and moving toward agricultural specialization.

Key Takeaways:

- Goals include increasing food security on university campuses, recruiting people to pursue agricultural careers, and using technology to reduce the cost of production.

- There is a need to investigate how technology can support farming, how to engage rural farming communities to use technology, and how to create specialized hubs in rural areas.

- Technological progress can greatly impact common practices; for example, cooking can be made more convenient, which could have a positive impact on health.

Session: Ethical Considerations for Future Workers: Maintaining Autonomy and Accountability in Increasingly Automated Workplaces

Participants considered the impacts and remedies for worker autonomy and accountability in the face of automation.

Key Takeaways:

- Humans are trading privacy for convenience, despite concerns around data ownership.

- Baby boomers and earlier generations were more concerned about data privacy than their younger counterparts. The value of privacy is shifting based on priorities.

- Research collaborations should involve multi-disciplinary teams to ensure accountability. There should be a human element at the center.

Dartmouth College
October 10, 2019

KEYNOTE ADDRESS
Future of Work Introduction

Leaders from Dartmouth, local and state government, and the NSF shared their vision for the Future of Work and the impact of new technologies in higher education and the workforce.

Key Takeaways:

- The Convergence Accelerator will speed up use-inspired, convergence research in areas of national importance. It will accomplish this via partnerships between academic and non-academic stakeholders. Areas of interest include enhancing public data use, AI and future jobs, and building talent for the Future of Work.

- The Future of Work is important both to the region and to the nation. Industry engagement, keeping up with other regions, and training students are critical concerns.

- Universities have an essential role in shaping the necessary skills for future workers. They need to deliver both new methods of teaching and pedagogy. Also, they need to apply technologies in workforce augmentation. Universities also have a role in looking at ethics and societal issues.

TOPIC: ILLUMINATING THE SOCIO-TECHNOLOGICAL LANDSCAPE

Session: Emergent Technologies & Pedagogical Approaches

Educational institutions are embedding coding, data science, and AI into the undergraduate curriculum. Educators are also concerned with human enhancement, not human replacement.

Key Takeaways:

- New technologies, data science, coding, and AI will become essential to undergraduate curricula.

- Industry partners recognize that many non-desk workers are at the frontline of human interaction. These workers use T-shaped skills (i.e., common sense, empathy, and reasoning) that are difficult to automate or replace.

- Employers need to offer their workers practical training and professional development.

- Memory and learning cognition studies can help us to understand learning. Increased comprehension will allow us to craft individualized plans for workers.

TOPIC: BUILDING THE HUMAN-TECHNOLOGY PARTNERSHIP

Session: Robotics and AI

Robots and AI can achieve complex tasks and problems but are not capable currently of performing all aspects of jobs; however, quantum and neuromorphic computing will have an impact. Industry 4.0 (the fourth industrial revolution and technological evolution) ranges from embedded systems to cyber-physical production systems.

Key Takeaways:

- Perception, mapping, control, planning, and coordination are a challenge for robots and need human interaction. Currently, robots can't replace people since they still need human development and programming.

- Employers will need to offer training and continuing professional development, increase safety and security, and deploy participative work design and lifelong learning measures. Employers need to align these components with developing workers' AI and robot skills.

- The "smart office" of the future will rely on batteries and wireless power transfer. Wireless power will become essential for untethered computers and robots. Medical implants and devices and vehicles will depend on batteries and wireless transfer, whether autonomous or not.

- Quantum and neuromorphic computing are emerging technologies. We need more skilled workers to help build and advance these technologies.

LUNCH DISCUSSION

The participants identified the most pressing needs within each sector. They also considered ways to address challenges related to new talent development and upskilling the existing workforce. They also discussed the unique challenges of states staying competitive with an aging workforce.

Key Takeaways

- There is an increasing need to move beyond retraining to cultivating lifelong learners. Meeting this need will rely on K-12 education, collaborative research, innovation in HR and workforce education, and implementation of new best practices.

- We need to consider non-desk job workers when thinking about the Future of Work and digital transformations in the workplace. More than 50% of most company employees fall into this category.

- In 2024, 25% of the labor force will be 55 or older. We need to determine optimal training approaches for this portion of the workforce.

Session: Ethical Perspectives

Technological developments can promote either labor-substituting or labor-complementing strategies. Institutions and policies will determine which use prevails.

Key Takeaways:

- We need to regulate new technologies and advancements to reduce inherent risks.

- Technological development can enrich the workplace by expanding production and free time, improving the organization, and reducing the need for repetitive work.

- Institutions and policies should shape the path of technological development. The aim should be to ensure that workers and jobseekers have adequate resources and equal opportunities.

TOPIC: ILLUMINATING THE SOCIO-TECHNOLOGICAL LANDSCAPE

Session: Workforce, Hiring, and Management

The Future of Work will affect current hiring processes, and AI will be a tremendous asset to improving matches between employees and employers. Also, there will be new parameters to measure the performance of workers of the future. New technologies will better engage employees with their daily tasks, increase workplace performance, enhance creativity, and lessen the burden of daily mundane tasks.

Key Takeaways:

- Machines can replace repetitive, structured work that humans are increasingly unwilling to do. This shift will leave creative work to humans.

- AI and wearable devices can measure performance. These technologies will help to improve working conditions and productivity.

- The current hiring process has many issues, especially for tech talent. These issues include quantity over quality, rampant fraud, and slow process.

- AI can reduce employer bias. Employers might otherwise overlook applicants' actual skills needed for success. Such skills are often not represented in resumes.

TOPIC: BUILDING THE HUMAN-TECHNOLOGY PARTNERSHIP

Session: New Approaches in Medicine

AI and other technologies are impacting patient health and medical diagnostics. AI, wearable devices, and VR improve the speed and accuracy of diagnostics by finding meaningful patterns in big data. The military is using new technologies to reduce the number of casualties.

Key Takeaways:

- AI is a powerful tool for healthcare, yet reproducibility is still challenging. Wearable computing systems have a critical role to play in the future of medicine.

- It will be necessary to establish trust between AI and clinicians and patients. Medical practitioners need to understand both the advantages and limitations of AI.

- The future of health will influence the work. To achieve the greatest benefit, we must integrate AI, wearable devices, and new technologies into patients' lives.

UC San Diego
October 15, 2019

DISCUSSION

Introduction to the Future of Work

The Future of Work means researching the intersection of workers and their technology. We need to consider how to design new technologies, how to define the emerging socio-technology landscape, and how to mitigate the risks and benefits of new technologies.

TOPIC: BUILDING THE HUMAN-TECHNOLOGY PARTNERSHIP

Session: The Human-Technology Frontier

It is crucial to consider how everyone throughout the workforce can access education so they can be successful. A large part of a successful workforce means teaching an experiential-based learning curriculum.

Key Takeaways:

- We need a strong, experiential, interdisciplinary, and project-based education system. Such a system is lacking within most P-16 education environments.

- Education access is an important consideration for nontraditional and underrepresented students in higher education and the workforce.

- We need to teach skills outside of the main areas of study. This broadness helps students to look beyond their traditional scope, allowing them to learn new ways of thinking to help them solve the problems of tomorrow.

Challenges and Solutions:

- The challenges of AI and ethics include the displacement of human activity and privacy and decision-making authority. Solutions include the use of communication tools to break barriers, oversight of data privacy and protection, and development of industry best practices for ethical decision-making.

- Challenges involving veterans and variously abled workers include removing the stigma of these workers, teaching empathy, measuring transferrable experience, and hiring best practices. Solutions include teaching empathy and cultural competence and developing measures soft skills in the hiring process.

- Inclusion and diversity challenges include defining "diverse," communicating about increased diversity and equity, and considering workplace culture versus individual/personal culture. Solutions include using technology to educate and increase cultural competency and policy for maintaining inclusiveness in the workplace.

- Future curricula and methods to prepare students face challenges including learning from failure, developing curricula, and maintaining generational knowledge transfer. Solutions include designing a curriculum that builds in failure to increase grit, teaching teamwork, and challenging our notions of data literacy.

- Cultural considerations include challenges around the presumption of understanding existing cultures, norms, and backgrounds, balancing workplace goals with work/life balance, and building cultural competency education into higher education. Solutions include creating an infrastructure that builds in knowledge and appreciation of different cultures in school and workplace and fostering a better understanding of work/life integration, not work/life balance.

- Challenges involving location and workplace logistics include remote work best practices. Solutions include creating more interpersonal interactions using technology, building in remote work design to new workplace design, and using telemedicine as a best practice for combining remote work with personal interaction.

TOPIC: ILLUMINATING THE SOCIO-TECHNOLOGICAL LANDSCAPE

Session: Diversity and Inclusion

The nation needs program development centered on the opportunity for youth to increase access to both education and workforce opportunities. Storytelling can help us to champion students who do not have the traditional resources and privilege to navigate the system. Focusing on the worker offers insights into the nature of the worker and about the nature of the work.

Key Takeaways:

- We need better partnerships among higher education institutions, industries, and local communities with a focus on going into communities to access diverse populations.

- Representation is critical in building a diverse talent pipeline. Organizations need to develop infrastructures for peer mentoring and coaching.

- Considering all phases of personal and professional life will lead to insights about diversity, equity, and inclusion in higher education and the workplace.

Challenges and Solutions:

- Challenges related to veterans and variously abled workers include making sure everyone has a voice, getting technology into the hands of all, and creating infrastructures to support people from different backgrounds. Solutions include increasing the presence of higher education institutions and industries in more communities, increasing access to emerging technologies.

- Public/private partnerships and economic development face challenges including broadening the impact of universities on the larger communities they serve, accommodating non-traditional modes of transportation, and improving the use of remote campuses to achieve outreach goals. Solutions include increasing proximity through multi-modal transportation and employing satellite workgroups to interface with the community.

- Inclusion and diversity challenges include discovering technologies that are needed to increase diversity, developing cultural core competencies within an organization, and improving students' soft skills. Solutions include employee resource groups that embrace different cultures and backgrounds, developing tech-based and intuitive learning platforms and committing leadership time to continued education.

- Challenges around future curricula and methods to prepare students include designing a human-centered curriculum that teaches how to be a person in the structure of a workplace and building strong and meaningful partnerships. Solutions include using a liberal arts model to design a human-centered curriculum, finding local champions in higher education and industry to create meaningful partnerships, and championing local experts in the community.

- Cultural challenges include defining inclusiveness, tokenism, and work/life balance issues. Solutions include expert training for students, staff, and employees, integrating inclusion and diversity from the top-down, and creating pathways to life balance, specifically with regard to child-rearing and eldercare.

- Location and workplace logistics challenges include building trust and rapport when working remotely and using proper technology etiquette. Solutions include prioritizing training for managers and using video to encourage interpersonal relationships.

University of Kansas
October 17, 2019

KEYNOTES

Session: The History of Work: Lessons for the Future

The first keynote speaker presented the historical context of labor and technology interactions and perspectives on how the Future of Work is evolving. Labor displacement by technology has been a constant theme for the last 250 years. Applied technology has created new jobs and an increased standard of living. Yet we need to consider the distribution of total income within an economy. Labor's share of total income has dropped.

Session: An Ongoing Transition to Automated Manufacturing

Two key drivers affect the evolution of work:

- Inefficient sectors drive technology solutions and labor displacement, and
- Factors such as distribution and energy drive decisions as labor becomes less of an input to a sector.

Key Takeaways:

- The historical trend of labor-technology-GDP may not be a valid model for the future.

- There is a need to examine the difference between labor displacement and workforce transition or mobility.

- The evolution of ubiquitous and homogeneous technology may be creating new vulnerabilities for society.

TOPIC: HUMAN-TECHNOLOGY PARTNERSHIPS

Session: Human-Technology Partnerships

The workforce's ability to use technology innovations to create better outcomes remains a challenge. Research suggests people may not make better decisions than AI, but they often prefer a human as the decider. We need to do more work on human-machine teaming to understand how or when people will cede decision-making to the machine. Researchers need to develop evidence-based assessments to help understand where technology improves outcomes.

Key Takeaways:

- The adoption of new technology by the workforce will occur voluntarily or be compelled.

- As technology takes over more functions, there is a question of whether human intelligence will evolve and whether humans can take over a task from autopilot.

- Digital technology is excellent at many memory/cognitive functions, but there remains the issue of how offloading will affect people.

Session: Perspectives on Lifelong Learning

The session included observations from the construction industry, defense, academia, professional development, and continuing education.

Key Takeaways:

- Every organization, regardless of sector, must be a learning center.

- The labor-management contract is a joint commitment to learn and to provide learning.

- The need for workforce development happens quickly, and the technology for delivering knowledge changes faster than our institutional structures for learning. Traditional models of degrees and a single transition from education to work are increasingly obsolete.

- Industry is becoming more integrated into the educational process before hiring.

- Lifelong learning is not just about workplace learning; it must also address the preparation that occurs in early childhood experience.

Bose and University of Massachusetts
November 13, 2019

Session: Future Of Work Introduction And Overview: Skills, Workforce, and the Academy

The nature of work is changing significantly, and the skills employers need are rapidly evolving. Employers will require more workers with an agile mindset rather than a set of traditional hard skills. This mindset includes socio-emotional intelligence, divergent thinking, the ability to work in teams, and to think critically to solve problems. The Future of Work will also require a shift in how workers are educated; a liberal education encourage agile thinking and lifelong learning.

Session: NSF Convergence Accelerator and the Future of Work

To deliver progress on scientific and societal challenges, it is necessary to take an approach at the highest level of interdisciplinarity and to involve multiple kinds of partnerships and stakeholders, including researchers and the ultimate users of research products. This is the guiding rationale for NSF's Convergency Accelerator, a new organizational structure designed to accelerate the transition of use-inspired research into practice to address research areas of national importance.

Key Takeaways:

- The program focuses on late-stage basic research to drive it towards translation and commercial development;
- C-Accel requires industry participation in the research;
- Initial tracks are Open Knowledge and Networks, Employees of the Future, and Employers of the Future;
- The 2020 project solicitation will be based on input from the research community.

Session: Human Technology Partnerships: Robotics

Trust will become a big factor as humans and robots begin to work together, and it is unknown what will be "normalized in this interaction over the next decade.

Key Takeaways:

- This is a young sector (startups often are begun by those in their 20s).
- Data and knowledge are not the same. Both are dependent upon an expert to input the information.
- A T-shaped professional profile is needed with disciplinary depth, but breadth in interdisciplinary capacities.
- There are new concerns about ethics for the future of work, such as muscular atrophy over time as we start offloading tasks to robots.

- NIST is creating ways to measure the forces exerted on workers and developing standards to test robot systems.
- Retraining human users is the hardest gap to bridge in the transition, but there is a need for people to build, train, and maintain robots.

Session: RealWear (Company Spotlight)

RealWear, a Vancouver, Washington-based company, has developed and produces a head-mounted wearable computer. The speaker discussed the safety and productivity aims of the product, how the technology interface affects workflow, and the challenges related to connecting human work with technology.

Session: Augmenting Human Performance: Field Workers and Worker Safety

Safety and productivity can be enhanced using technology, but workers with deep understanding of how tasks are performed should be consulted in the development of augmented reality tools intended to perform mundane tasks. In addition technology can be used to assess workers' health and stress, with learnings used to enhance productivity.

Key Takeaways:

- Wearable devices can measure in real time stress and fatigue, which affect worker performance. In addition to sleep interruption, the worker's ability make decisions and control surroundings can also affect health.
- All-day wearables that are affordable and deployed at scale allow workers to keep their heads up, hands free, and eyes free and complement work to increase productivity.
- Workers' knowledge is more complex, multi-dimensional, and nuanced, and should be utilized to ensure technology development matches conceived intent.

Session: Illuminating the Socio-tech Landscape

Work is increasingly becoming remote and digitally collaborative. Companies like Bose, IBM, and others are thinking about the impacts of this trend and how to grow into a better organization as a result.

Key Takeaways:

- Innovation enables others to build complementary products or services, leverages external ecosystems, and is heavily technology strategy related. It is multi-sided—a platform business—rather than functioning in a product-based structure.

- The use of networks is affecting how we work.

- There is tension between data as a proprietary asset versus data is open for public good. Businesses must think carefully about responsible stewardship of data.

Session: Future of Work: Ethics and Equity

This session featured leading voices from three different vocations on ethics and issues of equality as we venture deeper into a tech-based workplace.

Key Takeaways:

- There is a need to better understand what to tell workers about how to translate their value to different job.
- In terms of recruitment and support of a diverse workforce, age and socioeconomic diversity should be part of the discussion. Those more advanced in their careers may be more open to consider certificate-based programs than long-term degree programs. There is also a digital divide in terms of access to resources and training.
- There's a need to acknowledge the differences between self-interest, societal interest and organizational interests. Companies that develop specialized, in-house training programs are producing a narrowly trained workforce.
- Automation will increase jobs, eliminate jobs, transform jobs, and introduce new tasks within a job. But it only affects certain types of jobs and only benefits certain types of people. Jobs at highest risk of automation tend to replace worker groups with a higher concentrations of racial minorities.
- We don't yet know the effects of biases within AI systems.
- There is a natural tension between efficiency and equity. The pace of change is accelerating so quickly that we are not keeping pace in addressing the social implication of the technology revolution.

Session: Reskilling the Workplace

Work is becoming more accessible, and workers are working more years. A panel examined the ways in which work is changing and the challenges these changes present.

Key Takeaways:

- The "reskilling revolution" means an adaptable workforce is essential.
- Soft skills such as creative problem solving, critical thinking, cooperation, and collaboration are transferable and adaptive. But universities and traditional classrooms are not yet teaching these skills.
- According to United Nations statistics, 46% of the workforce over age 60 have some disability, and more are becoming disabled at a younger age. Return-to-work potential for those with disabilities is dependent on brain health rather than physical disability.

- For future prevention of disability and worker adaptation, focus should include cognitive flexibility as well as lifestyle characteristics, to include healthy diet, avoiding substance abuse, and exercise.
- Technology is producing new solutions for those with brain injury, including adaptation for return-to-work capability.

Moderated Discussion: How Companies and Universities can Partner to Address the Challenges and Opportunities Presented by the Future of Work

The NSF Convergence Accelerator program provides an opportunity for industry and universities to form partnerships that address industry needs. It is a later-stage research program that provides flexibility to add new partners during the first and second phase.

Conclusion

There is a need to strike a balance between efficiency (with technology support) and the human factors of equity, worker wellbeing, and the real need to continuously provide retraining opportunities for displaced workers. Because many jobs that we will see a decade from now have not yet been created, adaptability is intrinsically tied to the successful worker. Characteristics of the future workforce, and therefore academic preparation, should emphasize transferrable soft skills (creative problem solving, critical thinking, and collaboration), and acknowledgement of the need for lifelong learning. Because of the gap between the skills that industry needs now and current academic curricula, collaboration and cooperation between universities and industry is key to better structure traditional degree programs and specialty certifications.

UIDP COVID-19 Response Report

During the workshop award period, COVID-19 struck, and the entire nature of work was dramatically impacted.

In the wake of the COVID-19 pandemic, UIDP hosted a series of weekly calls to address challenges that arise from the need to shift from in-person meetings to remote collaboration approaches. The goal of these calls was to use a fast-lane approach to crowdsource ideas and solutions.

10 Key Themes

I.   Essential Research Continues

During what attendees called the ramp down, most university representatives estimated that only 10% to 25% of their on-campus research could continue. Experiments that could be performed remotely or in isolation were allowed to continue. Company representatives said that 80% to 100% of industry research was able to continue because it was either deemed essential or researchers were able to comply with social distancing and disinfecting requirements. Meanwhile, research related to COVID-19 escalated wherever possible.

II.   Impact of Work from Home

Although researchers who could not work from their labs produced record numbers of research proposals and journal submissions during this period, preliminary data from a reputable research university suggests that female researchers were not able to devote as much time to proposal writing as their male counterparts. Contracting personnel faced different challenges, such as shifting to an electronic signature process and the need to rapidly adopt new software and new processes.

III.   Communication

For the most part, universities were the primary drivers of communication. The most substantive complaint about communication arose during a discussion about talent recruiting. Company representatives felt that they could not adequately plan for their recruiting season without knowing whether or not students would be on campus. Company representatives felt inhibited by the level of uncertainty and long timelines for university decision making specific to fall recruiting.
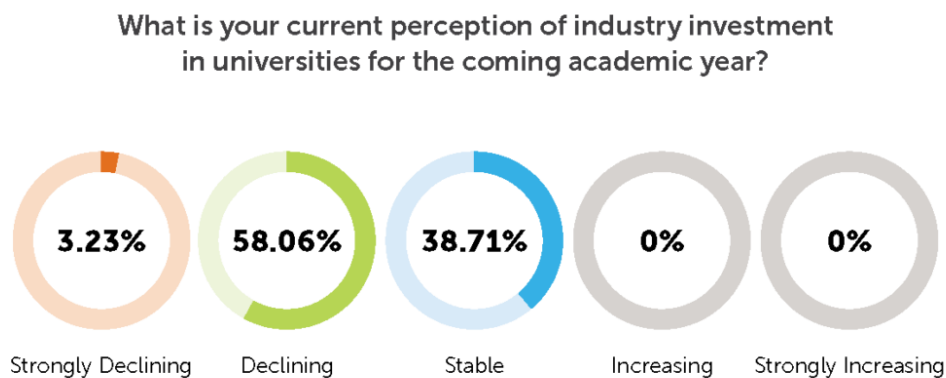
IV.   No-Cost Extensions

Participants estimated that most research projects could absorb two months of working from home without issue. After that period, most projects would be impacted. Research projects nearing completion or having an overall duration of less than two years were the first to be evaluated and modified to address the lack of lab access. Many company representatives expressed a willingness to provide universities with no-cost extensions, especially to cover student support. These no-cost extensions (NCEs) solve short-term problems but will lead to funding shortfalls later.

V.   Force Majeure

Most companies and universities strive to be flexible instead of enforcing force majeure. The expectation at the onset of the pandemic was that companies would invoke force majeure. Instead, force majeure was invoked by some universities when they felt that following through with their contractual commitments was impossible. Due to the uncertainty caused by coronavirus, representatives report that many new contracts now include clauses that address the challenges that came to light in 2020.

VI.   Funding

Funding for university-industry partnerships is expected to decrease in the next year. A large amount of research funding was available for COVID-19–related research, and by and large, companies were also honoring their existing financial commitments to universities, although restructuring payment timelines was common. While research funding levels are still not fully known, company representatives were transparent about the fact that recruiting budgets have been slashed significantly due to the larger economic downturn caused by the pandemic. The decline in state funding for higher education is another funding challenge. Many UIDP members are searching for low-cost ways to stay connected with their research partners.

What is your current perception of industry investment in universities for the coming academic year?

3.23%	58.06%	38.71%	0%	0%
Strongly Declining	Declining	Stable	Increasing	Strongly Increasing

Survey fielded July 6-13, 2020

Figure 1: Current Perception of Industry Investment in University Research

How likely are you to pursue new university-industry partnerships in the next 12 months?

3% Unlikely

7% Somewhat Likely

13% Somewhat Unlikely

45% Very Likely
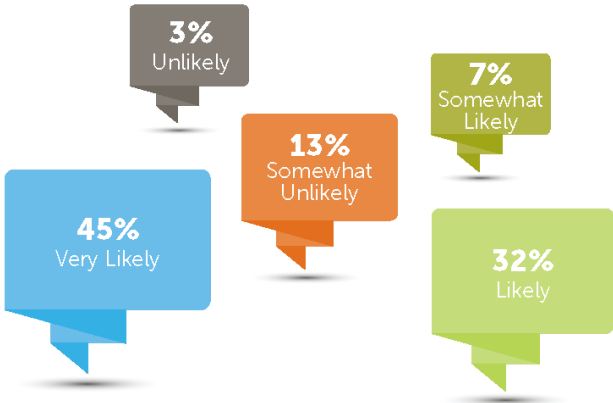
32% Likely

Survey fielded July 6-13, 2020

Figure 2: Likelihood that Industry Will Pursue New Partnerships

VII.   Level of Partnership

Most companies and universities are working exclusively with their closest strategic partners; one-off or transactional university-industry collaborations are largely on hold. However, most representatives expressed a willingness to pursue new partnerships.

VIII.   Building Partnerships in a Virtual Work Environment

The pandemic has forced people to become more adaptable. Despite the technical challenges of working remotely, discussion participants felt that trust could be built via online-only relationships. An unexpected challenge is that online meetings tend to be business focused. To build personal connections through online meetings, an intentional effort must be made.

What is the most important aspect of university-industry collaboration over the next 6 months?

Access to Resources **11%**

Students **42%**
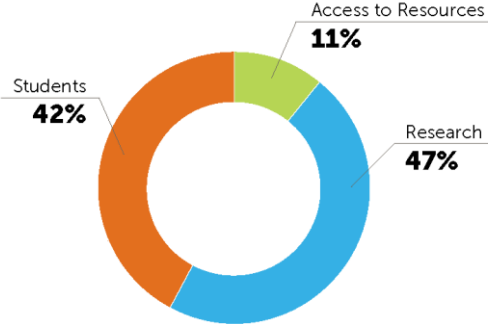
Research **47%**

Survey fielded April 30-May 6, 2020

Figure 3: Most Important Aspect of University-Industry Collaboration

IX.   Student Engagement

Traditionally, the top three reasons for companies and universities to collaborate have been research, students, and access to resources (such as specialized equipment). Among participants in the COVID-19 Response Discussions, 42% said that student recruitment and access to talent would be the most important aspect of university-industry collaboration in the next six months.
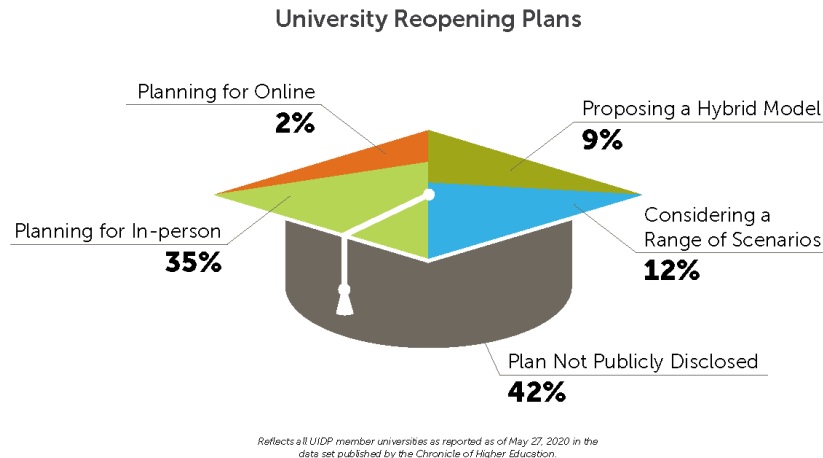
University Reopening Plans

Figure 4: University Reopening Plans

X.   Student Recruitment

For companies, recruitment strategy has been impacted at all worldwide locations due to COVID-19, and they are strategizing for the future. Professionals in recruiting and workforce development emphasized the importance of employers staying present on university campuses and continuing to make connections with the future workforce.

One big challenge for companies is the uncertainty that they have around whether students will be on university campuses. Figure 4 reflects public statements that UIDP member universities made at the time of the COVID-19 Response Discussion.

Acknowledgments

APPENDICES

    I.   Site Report, University of Central Florida, September 24, 2019

    II.   Site Report, Case Western Reserve University, October 1, 2019

    III.   Site Report, Dartmouth College, October 10, 2019

    V.   Site Report, UC San Diego, October 15, 2019

    VI.   Site Report, University of Kansas, October 17, 2019

    VII.   Bose & University of Massachusetts, November 13, 2019

    VIII.   COVID-19 Response Report