NOV. 12, 2019 Leaders from The Boeing Company, Ford, HERE Technologies, and Uber convened at the Cahn Auditorium in Evanston for the Fall 2019 Industry Technical Workshop "**Virtual Reality in Transport Innovation,**" hosted by the Northwestern University Transportation Center (NUTC) and the Center for the Commercialization of Innovative Transportation Technology (CCITT).

Bret Johnson, Senior Associate Director of NUTC and Director of CCITT, introduced four forward-looking leaders who are actively engaged in the use of innovative technologies. The audience saw several examples of how Extended Reality technology, also known as XR, can be applied in the whole product cycle of the manufacturing process, improving transportation safety, and experiencing new modes of transportation that were once thought to be science fiction.

BOEING: The product cycle consists of the design, manufacturing, and retail stages. Boeing has long been at the leading edge of aviation and has no plan on slowing down with XR technology being incorporated in each stage of the product cycle. **James Fadenrecht**, Leader of Boeing Commercial Airplanes Visualization Center of Excellence, outlined how the new age visualization technology assists engineers with placing millions of parts together. Using proprietary XR tech, engineers translate 2D design plans into 3D depictions to understand how the smallest change like moving electrical wires mere inches can affect the entire airplane. XR is also used to depict what the manufacturing process may look like with human models included to show how the planes can be assembled. Finally, commercial airliners purchasing planes from Boeing can customize and view their fleet well before the physical product reaches their hangers.

FORD: Ford uses XR in its product cycle for automobiles. **Ilan Weitzer**, an Information Technology Technical Manager in Advanced Manufacturing at Ford, focused on the trends and advances of Ford's Enterprise-wide Extended Reality Adoption and how its role in the company quickly grew. From the 1990s to early 2010s, the high cost and limited availability of this technology resulted in a limited application of it. Now that it has become pervasive with recreational applications, the cost of its use in business applications has decreased. As such, XR is beginning to be implemented in every part of Ford, from design to manufacturing engineering to production to sales and service. One important application of XR is in product development. These technologies allow Ford product designers to reinvent vehicle design by overlaying

design changes on existing vehicle models to assess the changes' feasibility. Rather than creating clay models each time there is a change to the automobile's exterior, engineers can seamlessly replace doors, mirrors, headlights, and other parts on a digital framework.

HERE: XR technology also has application outside of physical goods. It is being used to improve transportation efficiency and safety. Dr. **Xin Chen**, Director of Engineering at HERE Technologies discussed the process of creating and maintaining high-definition maps, applications of these maps for autonomous vehicle training, and the role of augmented reality with detailed map information.

While many of us are familiar with navigation maps and their road-centric attributes like speed limits and turn restrictions, the maps created and maintained by HERE Technologies incorporate lane-level topology with centimeter-level accuracy. Many self-driving car companies are already using these maps to train their algorithms on real-world datasets without having to deploy vehicles. With this rich information, drivers in the real world have access to more accurate navigational steps that can be shown in a Heads Up Display or even overlapped on physical features with XR technology. Through the creation and maintenance of high-definition maps, HERE Technologies is improving congestion, reducing pollution, supporting the advancement of autonomous vehicle technology, and saving lives.

UBER: From the product cycle to improving transportation safety, XR is also used to let people experience the next step in transportation innovation. **Zhuyun Gu**, Data Scientist at Uber, presented about the Future of Urban Air Mobility, specifically with regards to implementing an on-demand urban air service using an UberPool model. Uber uses XR to imagine a new service that only a few years ago was considered science fiction. The value proposition is to circumvent ground-level traffic and congestion by flying electric helicopters between "Skyports" on top of buildings. Uber would offer end-to-end trip transportation, providing first and last mile travel with Uber ground services bridged by the longer-distance Uber Air service.

To meet Uber Air's goal to launch in Los Angeles, CA, Dallas, TX and Melbourne, Australia in 2023, data scientists predict demand and determine the infrastructure needed to make it happen. To determine demand, Uber aggregated internal data, publicly available data, and performed a survey based on previous travel behavior and demographics to determine the potential

market share of Uber Air. With the data fully analyzed, what this future looks like with skyports, electric helicopters, and the is the existing built environment is visualized with XR. Before even the early adopters take their first flights, the public can experience Uber Air years before its rollout.

PANEL / Q&**A**: XR is being applied to a variety of sectors in the transportation industry and shows no signs of slowing down. The technology is becoming such a mainstay of companies' toolboxes that Boeing has even begun to address the side-effects of long-term XR exposure. Though certainly not affecting every user, some XR users experience nausea and disorientation, and the company is working to make ensure that their workforce can safely use the stellar technology.

As XR technology continues to improve with new features such as eye-tracking and wider fields of view, the presenters participated in a panel discussion moderated by Dr. Hani S. Mahmassani, Northwestern University Transportation Center Director. The panel received questions from the audience about testing equipment for people with special needs, how the skill set requirements change for the workforce as XR technology continues to be adopted, and how XR can continue to be a valuable asset. Mr. Fadenrecht of Boeing spoke about integrating XR with devices that incorporate touch and feel (haptics) so that the experience can be used by more people. Panelists also discussed how XR adoption is occurring

during a transitionary stage where some employee re-training is required, including the most digitally saving workers. Mr. Fadenrecht pointed out that expecting younger people to be more enthusiastic about these technologies is not entirely accurate.

The panelists collectively agreed that younger workers still find that current XR technology is not as intuitive as traditional methods design and manufacturing. On the other hand, experienced individuals seem to be quite open to adopting it. Regarding the skillset needed for an XR workforce, Dr. Chen from HERE Technologies identified strong backgrounds in mathematics and computer programming as core skills for the development and application of XR technologies. The panel also discussed obstacles to the widespread adoption of XR. identified that one barrier raised by Mr. Weitzer of Ford is the integration of data sets with XR platforms which is providing to be a challenging task.

CONCLUSION: The Fall 2019 Industry Technical Workshop shed light on advancements in XR technology and integration within the transportation industry. The future is bright with companies finding ways to incorporate new technology in the product cycle, transportation safety, and imagining what the world can look like with electric helicopters. As the technology continues to improve, it is exciting to witness how XR can help define the future of transportation.