WTDB Report: Talent Development for Artificial Intelligence in a Post-Pandemic World

Oregon Workforce and Talent Development Board

Artificial Intelligence Task Force

October 2020

Final Report

ARTIFICIAL INTELLIGENCE (AI) TASK FORCE

Oregon's Workforce and Talent Development Board (WTDB) is the Governor's core leadership and advisory board for the interconnection and alignment of education, training, and talent development in Oregon. The WTDB leads the state's thinking on the future of work and is focused on understanding the skills that working Oregonians need for current and future jobs. A key goal of the WTDB is to equip Oregon's businesses, employers, citizens, and public officials with the informational resources, innovative strategies, and tools necessary to move Oregon into a future of equitable prosperity for all of our local communities.

In the **2018 Oregon Talent Assessment**, the WTDB laid out the state's in-demand occupations, in-demand skills, talent gaps, and trends.[1] The report introduced a common taxonomy of skill problems and diagnosed conditions through a combination of employer surveys and analyses of economic data. The assessment showed that employers did not perceive basic skills gaps but did see a shortage of skills required for specific occupations—with problem solving and critical thinking at the top of the list. Employers signaled a high demand for engineers, skilled tradespeople, and project managers. And the report concluded that key interpersonal skills (e.g., leadership, honesty, ability to work in teams) are lacking while also growing in importance. This assessment served as a foundational document for the 2020-2021 WTDB Strategic Plan.

The **WTDB 2020-2021 Strategic Plan** calls out a vision of equitable prosperity for all Oregonians and a mission of advancing Oregon through meaningful work, training, and education by empowering people and employers.[2] The plan is intended to be transformative for the talent development system in Oregon. It provides direction and action steps to increase innovation, efficiency, effectiveness, and overall results. Strong leadership, forward thinking, and solid strategy provided the impetus for the development of this more-relevant, 2-year strategic plan. This same leadership was responsible for the formation of the AI Task Force. Ken Madden, with Madden Industrial Craftsmen and Chair of the WTDB, and former WTDB board member Gary Brown (retired) and current WTDB member KS Venkatraman, both with NVIDIA, were instrumental to the vision and development of the AI Task Force.

The **WTDB 2020 Talent Assessment** acknowledges that postsecondary educators and workforce developers are operating in challenging times.[3] The precise pace of technology's progress may be unclear, but most observers agree that advances in robotics and AI will disrupt occupations and demand that workers continuously upgrade their skills throughout their careers. These advancements and disruptions, coupled with other issues and opportunities called out at the June 2019 WTDB discussion on AI talent development, resulted in a recognized need for more formal AI education and

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[1] ECONorthwest and Program and Policy Insight. (2018). *Oregon Talent Assessment*. Portland, OR. https://www.oregon.gov/workforceboard/talent/Documents/2018%20Talent%20Assessment%20-%20FINAL.PDF

[2] Oregon Workforce and Talent Development Board (WTDB). (2020). *2020-2021 Strategic Plan*. Salem, OR. https://www.oregon.gov/workforceboard/board/Documents/191021%20-%20WTDB%20Strategic%20Plan%20-%20FINAL%20One-Page%20Plan.pdf

[3] ECONorthwest. (2020). *Oregon Talent Assessment 2020 Update*. Portland, OR. https://www.oregon.gov/highered/institutions-programs/workforce/SiteAssets/Pages/talent-summit/2020%20Talent%20Assessment%20Update.pdf

training programs to meet the talent needs of Oregon businesses and employers. In response, the WTDB AI Task Force was established.

The WTDB, its leadership, and the Higher Education Coordinating Commission (HECC) would like to acknowledge and thank all of the thought leaders from around the state that participated in the work of the AI Task Force, on the Education Sub-Committee and/or by contributing your time and efforts on the report. Your commitment to the success of Oregon and its citizens, your innovative and solutions-oriented thinking, and your leadership and passion around helping to improve Oregon's talent development system is exemplary.

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EXECUTIVE SUMMARY

The WTDB Artificial Intelligence (AI) Task Force was officially established in 2019 by the Chair of the Oregon Workforce and Talent Development Board, Ken Madden. One of the key goals from its inception was to produce a report for the Governor's Office and Legislature on the impacts of AI, including recommendations on how to increase Oregon's AI talent pool.

Charter highlights

The task force is entrusted with leading efforts across public and private sectors to discuss, research, and understand the unique challenges and opportunities related to education and training in AI for Oregon. Topics of interest include understanding the economic and societal implications of AI while ensuring rapid innovations in AI benefit Oregonians as fully as possible. The task force is also charged with developing and providing to the Governor and Legislature prioritized strategy and policy recommendations that prepare Oregon and its workforce for the transition to AI technology. This first-ever WTDB report on the implications of AI is not meant to be all inclusive. WTDB members envision delivering a series of reports over the next several years on the impact of AI on Oregon's citizens, economy, jobs, and communities. The AI Task Force conducted research and gathered intel from multiple sources, including representatives from the private and public sectors and nonprofits, and sources from across the U.S. and around the globe. Although the COVID-19 pandemic presented challenges, the task force has continued its work through the pandemic on schedule.

Report structure

Throughout the development of this report, the State of Oregon Equity Framework and the Governor's equity values were woven into discussions, strategies and activities of the task force. The report begins with a brief introduction to AI and then moves into sections on COVID 19 and AI, Climate Change and AI, Current Conditions for Families and Workers, Ethical Implications and Considerations, and AI Strategies and Outlook, which is followed by some telling, yet not surprising, data on youth. The report takes a cursory dive into AI's Sector-Based Impact as seen, in part, from the lens of members of the WTDB and from other leaders across Oregon. Economic development and federal and state government are also covered. Education and Training are then discussed, with the report culminating in Policy Recommendations to the Governor's Office and the Oregon Legislature.

Key findings

- Societal and ethical aspects of AI will affect state workforce policy, especially on equity, fairness, and bias issues.
- Low-income individuals, communities of color, rural communities, and other underserved populations will experience barriers to employment with increased use of AI, requiring effective state workforce policy.
- Human skills and essential employability skills will continue to grow in importance as AI expands its influence.
- Sectors will drive the needs, application, and development of customized AI and use.

- A two-pronged education and training approach to build AI developers and, more importantly, AI users is critical for P-12 and postsecondary institutions.
- Public-private partnerships are key to building AI talent pools.
- Outcomes-based funding models can help to build talent pipelines for Oregon employers.

INTRODUCTION

Artificial intelligence (AI) technology has created new markets and opportunities in our economy, in sectors such as agriculture, education, energy, healthcare, technology, finance, and the environment. AI has surpassed human capability in fields like image recognition, game playing, speech recognition and generation, predictions based on data analytics, and art and style transfers. Growth in AI will contribute to AI continuing to exceed human performance on more tasks, creating significant future economic expansion. While many will benefit from these advancements, aggressive policy action will be required to equip all Oregonians with the skills needed to succeed in and benefit from this Fourth Industrial Revolution.[4]

Some celebrate while others lament the changes upon us and the consequences for the American workforce that come with these technological advancements.

Electricity and the internal combustion engine are historical examples of general-purpose technologies that not only had direct contributions to society but also enabled complementary innovations. Electricity gave rise to factory automation, telegraphic and wireless communication, refrigeration, and many more innovations we take for granted today. The internal combustion engine revolutionized modern transportation via the automobile, jet engines, shipping, and logistics networks.

AI is expected to have a greater socioeconomic impact than the internet.[5] It will revolutionize how we live, work, learn, discover, and communicate, with the potential to increase productivity and create high-wage, sustainable jobs.

The current economic landscape, the increasing pace of AI adoption, and the need for AI talent have influenced the work of the WTDB. In June of 2019, the WTDB established the AI Task Force to help lead efforts on education and training programs in the AI field for Oregon.

Oregon's public workforce system is rarely cited as a resource to help navigate the future. Many workforce initiatives are aimed at more-immediate concerns such as increasing equity and inclusion, developing certificates and credentials, advancing career resilience, and creating economic security for Oregonians with barriers. As such, this task force is in lock step with Governor Brown's Office and has integrated the State of Oregon Equity Framework in COVID-19 Response and Recovery Framework into its discussions and this work.

However, the WTDB is challenging current perceptions about its work by providing future-focused leadership that strives to provide better connectivity and improved alignment between the public system and the talent needs of the private sector and other employers in Oregon. A key end goal remains: to help more Oregonians get a job or get a better job. To this end, the future must include Oregonians educated and trained as AI developers and AI users. Policy leaders must employ AI to analyze workforce data across public agencies and economic sectors, leading to better identification of

[4] World Economic Forum. (2020). "Fourth Industrial Revolution." Cologny, Switzerland. https://www.weforum.org/focus/fourth-industrial-revolution

[5] Sparks, Evan. (2019). "AI Leadership and the Positive Impacts on Economy, Privacy, and the Environmental Health." *Forbes,* November 14, 2019. https://www.forbes.com/sites/evansparks/2019/11/14/ai-leadership-and-the-positive-impacts-on-economy-privacy-environmental-health/#14c9b780327e

critical problems and meaningful solutions.

Beyond this report, much work remains to evaluate the impact of AI in all sectors of Oregon's economy. This report will focus on developing formal education and training programs in Oregon to help build the state's AI talent pool.

WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial intelligence is the ability of a computer or machine to perform tasks that normally require human intelligence.

It is a collection of capabilities like visual perception and spatial awareness, speech recognition, language translation, and analytical predictions that lead to decision-making. These technologies accelerating independently have paved the way for AI, a general-purpose technology that enables machines to sense, learn, comprehend, and act with intelligence similar to humans.

The ability of an AI system to learn is fundamental and differentiates it from traditional algorithms that are explicitly programmed to act in a predefined manner. A human brain learns throughout life to understand and process information. Similarly, a machine learning algorithm or model must be trained to comprehend its environment and produce desired outcomes.

Recent examples of AI include IBM's Watson supercomputer, which used a natural language processing algorithm called DeepQA to defeat Ken Jennings and Brad Rutter, two of Jeopardy's greatest human champions.[6] In 2016, AlphaGo, an AI system developed by Google's DeepMind, defeated the world's best professional Go (highly complex board game) player Lee Sedol. This was accomplished by teaching AlphaGo the rules of the game, showing it human game-playing sessions, and allowing it to play against itself to improve and surpass human capability. Today, self-driving cars and trucks can process and classify video streams from cameras with information aggregated from sensors around the vehicle to map their environment and detect pedestrians, objects, vehicles, and traffic signs to navigate safely towards their destination.

AI or variants of it have existed for more than 50 years. The Turing machine created during World War II is an early example. Since then, the technology has been through peaks of immense media attention and valleys of "AI winters" with reduced research and industry funding. Recent advancements in big data and accelerated computing have propelled a field of AI called deep Learning. Deep learning algorithms and models mimic multi-layered neural networks in the human brain. These models are being deployed at an unprecedented rate, transforming the way we live, work, travel, create, consume, and interact.

According to the World Economic Forum's report, opportunities in emerging professions influenced heavily by AI like the care economy, marketing, data science, cloud computing, product development, and the green economy will increase by 51 percent (to 2.4 million opportunities) by 2022.

[6] Best, Jo. (2013). "IBM Watson: The Inside Story of How the Jeopardy-Winning Supercomputer Was Born, and What It Wants to Do Next." *TechRepublic*, September 9, 2013. https://www.techrepublic.com/article/ibm-watson-the-inside-story-of-how-the-jeopardy-winning-supercomputer-was-born-and-what-it-wants-to-do-next/

COVID-19 AND AI[7]

In March 2020, Oregon and the nation entered into a severe recession virtually overnight due to the outbreak of COVID-19 and the public health measures enacted to contain it. The state lost 272,000 jobs in two months, wiping out six years of job growth. Meanwhile, the unemployment rate soared from the lowest on record to the highest in a single month.

The long path to recovery began in May as restrictions were lifted or relaxed and businesses adjusted. By July, the state had regained nearly 40 percent of the jobs lost in the early months of the pandemic, and the unemployment rate declined from 14.9 to 10.4 percent. While most major industries added jobs during the late spring and early summer, all remained below pre-pandemic peaks as of July. This job loss has disproportionately impacted women, people of color, and low-income and rural communities.

While the economy has transitioned from a deep recession to a fledgling recovery, the rest of the story will be dictated by the course of COVID-19. At this time, the virus is in control but until there is a vaccine or treatment, businesses and consumers will remain cautious and constrained, causing subdued spending and job growth. The Office of Economic Analysis expects that Oregon will return to its pre-pandemic employment levels within 3 to 4 years following the development of a vaccine.

Geographic profile of COVID-19 pandemic effects

The economic fallout from the pandemic has affected every community in Oregon, both urban and rural, but not uniformly. Tourism-reliant regions were hardest hit, notably the North Coast and Central Oregon, and trail the rest of the state in the early stages of economic recovery. Several metro regions also lag in the recovery: Corvallis, Salem, Grants Pass, and Portland.

Looking ahead, the Office of Economic Analysis expects that the recovery will be geographically uneven due to differing regional industry structures. Professional and business services (e.g., engineering, legal, research and development, accounting) will be a strong long-term driver of growth. Because this sector tends to be more concentrated in urban areas, the Portland region, the Willamette Valley, and Central Oregon stand to see greater job gains. Several of the state's rural counties also have a relatively high concentration of employment in this sector and should also benefit: Coos, Douglas, and Klamath.

Conversely, natural resources and manufacturing are likely to see slower growth and more permanent damage from the recession. Rural Northeastern Oregon and urban Yamhill and Linn counties rely more heavily on these industries and consequently will experience slower growth in the coming decade.

Structural changes from the COVID-19 pandemic

Time will tell as to the full extent of damage from the pandemic and the resulting structural changes to

[7] Oregon Employment Department, 2020 (unless otherwise noted).

the economy. The longer restrictions are necessary, the more permanent the damage will be.

In the near term, the most vulnerable workers (as measured by wages) have been disproportionately affected. Retail trade and leisure and hospitality, which pay around $35,000 or less, have accounted for 40 percent of job losses yet make up just 20 percent of the economy.

Over the long term, the Office of Economic Analysis expects structural changes in select industries: manufacturing, retail, and commercial construction. Manufacturing will likely face broken supply chains resulting from the pandemic for years to come. Retail will continue to be affected by the rise in e-commerce while commercial construction will likely see lower activity due to increased office vacancies, a shift toward telework, and fewer hotel projects due to decreased travel demand. All three of these industries will comprise a smaller share of the economy over the next 10 years than was forecasted prior to the COVID-19 pandemic.

A WDTB addendum to the 2020 Talent Assessment, developed by ECONorthwest, provides an in-depth look at the disproportionate impact of the pandemic on the leisure and hospitality industry and its occupations and workers. The analysis highlights adjacent occupations that draw on substantially similar skills and could be options for some dislocated workers. It also identifies the demographic characteristics (e.g., race, ethnicity, and socioeconomic status) of individuals typically employed in the industry and evaluates geographic concentrations of the occupations across the state. Employers and workforce experts who participated in roundtable discussions held in collaboration with the Oregon Business Council (OBC) agreed that certain industries may not fully recover from the current recession until well after a vaccine is developed and deployed.

More on the COVID-19 pandemic and AI

Kartik Hosanagar of the University of Pennsylvania's Wharton School of Business teaches a course on the business ramifications of emerging technology. Interest in the AI part of the class has been so high that Hosanagar and Wharton recently announced a new initiative called Wharton AI for Business.[8]

As mentioned by outgoing Wharton Dean Geoff Garrett, "The advances made possible by artificial intelligence hold the potential to vastly improve lives and business processes [...] Our students, faculty, and industry partners are eager to join in our AI knowledge creation efforts to more deeply explore how machine learning will impact the future for everyone."[9]

The project includes a new course on the business implications of AI and a guest lecture series. The AI for Business project is funded by a $5 million gift from Tao Zhang and Selina Chin, the Wharton alumni couple who founded the food delivery app Dianping and run the Singapore-based Blue Hill Foundation.

Hosanager notes that companies will be thinking more about how AI can help their employees—including those working at home—increase productivity. Companies will also be looking for ways to save money using AI. Other predictions noted by Hosanager include:

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[8] Artificial Intelligence for Business. (2020). "AI for Business: Analytics at Wharton." The Wharton School, The University of Pennsylvania. Philadelphia, PA. https://analytics.wharton.upenn.edu/programs/ai-for-business/

[9] Patel, Dee. (2020). "Wharton School Announces New AI for Business Initiative." *Penn Today*, June 30, 2020. https://penntoday.upenn.edu/news/wharton-school-announces-new-ai-business-initiative

- The immediate economic situation might make it difficult for companies to think strategically about AI.
- Factory automation and robotics will accelerate.
- The impacts could level the playing field for start-ups (history and experience are less of an advantage because of the disruption and discontinuity caused by the pandemic).
- The pandemic will accelerate the use of unsupervised learning algorithms.
- There will be a greater role for reinforcement learning, where AI software learns from simulated experience.

A report from *MIT Technology Review* and Faethm explored data and "remoteable" jobs and the extent to which these can be supported by AI technology in the future.[10] Highlight takeaways from the article include:

- The COVID-19 pandemic will accelerate the pace of AI innovation.
- Jobs that require human interaction are fertile ground for AI (and other) technology that reduces health and productivity risks.
- Faethm looked at occupations by the degree of human interaction and by how well suited they are to remote work. "Across all categories, the data reveal there are about 32 million workers highly exposed to pandemic risk, because they require human interaction and are not easily converted for remote working."
- Overall, pandemic preparedness accelerates the pace of AI innovation in high-risk job categories, causing both "job-positive" and "job-negative" effects.
- "Over the longer term, governments should guide industrial development, technology policy, and education systems toward ensuring national resilience in the next pandemic. This includes providing support for businesses that provide essential front-line services and ensuring that high-risk roles benefit from best available technology in the future."[11]

CLIMATE CHANGE AND AI

Globally, climate change is one of the greatest challenges facing humanity. The adverse effects brought on by increasing variability in the environment become more apparent every year. On a regional scale, Oregon's climate is getting warmer, resulting in less snowpack, severe wildfires, and reduced stream flows.

In September 2020 alone, Oregon saw a rapid expansion of multiple wildfires, with approximately 1 million acres burning in just 3 days, 40,000 evacuations, and 500,000 people in evacuation warning areas. The air quality index in many towns and cities plummeted to the worst on the planet.

According to a 2019 report by The Oregon Climate Change Research Institute (OCCRI),[12] Oregon is

[10] MIT Technology Review Insights and Faethm. (2020). "COVID-19 and the Workforce: Critical Workers, Productivity, and the Future of AI." *MIT Technology Review*, April 30, 2020. https://www.technologyreview.com/2020/04/30/1000888/covid-19-and-the-workforce-critical-workers-productivity-and-the-future-of-ai/
[11] Ibid.
[12] Mote, P.W., J. Abatzoglou, K.D. Dello, K. Hegewisch, and D.E. Rupp. (2019). *Fourth Oregon Climate Assessment Report State of Climate Science: 2019, Summary*. Oregon Climate Change Research Institute. Corvallis, OR.

projected to warm up to 9 degrees Fahrenheit (F) by 2100 and to experience a rise in extreme precipitation and sea levels, affecting our coastal communities. By the middle of the century, hot days above 86 degrees F will be prevalent. Climate change not only impacts our food supplies, but also exacerbates societal challenges like food and housing insecurity.

AI can be a powerful tool to reduce carbon emissions and help society adapt to the inevitability of climate change. Reducing emissions requires changes to infrastructure like power generation and distribution, transportation, construction, manufacturing, and land use. Societal adaptation requires better planning for disaster management.

AI researchers published a paper in 2019 with recommendations on how AI can help address climate change.[13] These applications are rated below in terms of leverage and timeframe that are relevant across Oregon's many sectors discussed later in this report.

Electricity systems

- Accurately forecast power supply and demand; integrate forecasts into weather models to prevent electrical fires.
- Gather statewide data on electricity systems to build better models.

Transportation

- Phase out internal combustion engines in favor of electric vehicles. AI models can influence charging schedules, integrate electric vehicles into the electrical grid, and optimize battery and energy storage technology with new material discovery.
- Create usage and demand models to inform infrastructure decisions to a) improve freight routing and personal transit and b) pinpoint vulnerable areas for improving roads and bridges to handle the increasing frequency and severity of extreme weather events.

Buildings and construction

- Use models to predict and reduce energy consumption; control temperature and lighting based on occupancy patterns.
- Develop techniques that require less raw material and accelerate the discovery of carbon-friendly replacements to steel and cement.

Food and agriculture

- Reduce food waste by optimizing delivery routes, forecasting demand, improving refrigeration systems, and identifying spoiled produce.
- Accelerate the discovery of new electrocatalysts or proton conductors for use in ammonia production.
- Reduce the need for chemical fertilizers and pesticides by using AI-based robotic systems to pinpoint pests, diseases, and weeds.
- Monitor risk of food shortages in real time, forecast crop yields, and improve resilience of food supply chains.

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http://www.occri.net/media/1092/execsummaryocar4.pdf

[13] Rolnick, David, et al. (2019). Tackling Climate Change with Machine Learning. *ArXiv Preprint*, ArXiv:1906.05433; Climate Change AI. (2019). "Interactive Summary." https://www.climatechange.ai/summaries

Forests

- Automate afforestation in chosen locations via tree-planting drones to help sequester carbon, monitor plant health, and assess weeds.
- Use imagery to track illegal deforestation and provide tools for sustainable timber harvesting and forest management.

Education

- Use AI models to enable personalized and scalable educational tools to improve the resilience of communities to climate change and to encourage the adoption of more-sustainable lifestyles.

Evaluating policy effects

- Use AI systems to track how previous policies have been effective by performing causal inference on historical data.

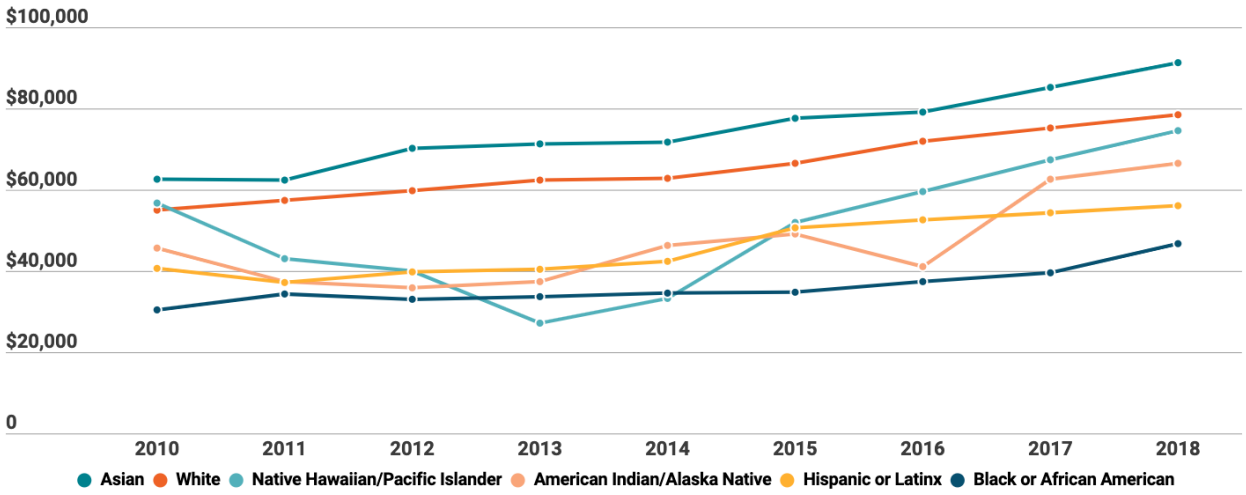
CURRENT CONDITIONS FOR FAMILIES AND WORKERS

Inequitable prosperity during inequitable recovery

The economic "rising tide" that followed the Great Recession did not lift all boats equally. Even though the median household income increased significantly during the recovery, the inequities between some communities were higher at the end of the recovery than before the recovery. Figures 1 and 2 show substantial differences between median household incomes and between median hourly wages for White people compared with people of color.[14]

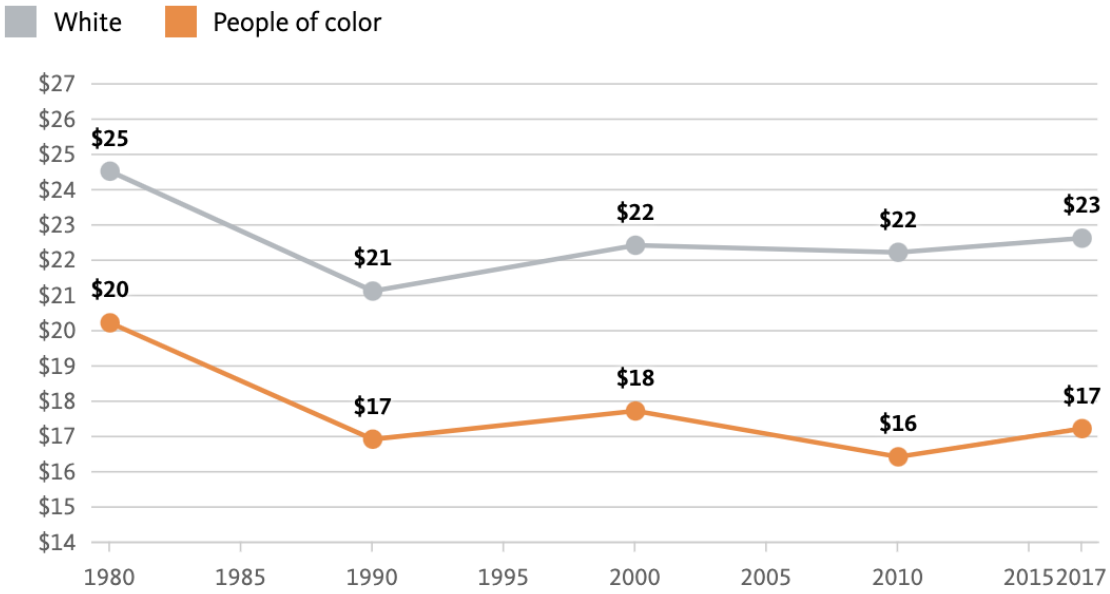
[14] Center for the Study of Social Policy. (2020). Recognizing Race in Language: Why We Capitalize "Black" and "White." https://cssp.org/2020/03/recognizing-race-in-language-why-we-capitalize-black-and-white/

Figure 1. Median household income (MHI), Portland, by race/ethnicity (2018$)



Source: Portland Business Alliance. (2020). 2020 Value of Jobs, State of the Economy. Portland, OR.

Figure 2. Median hourly wage by race/ethnicity, Oregon, 1980-2017



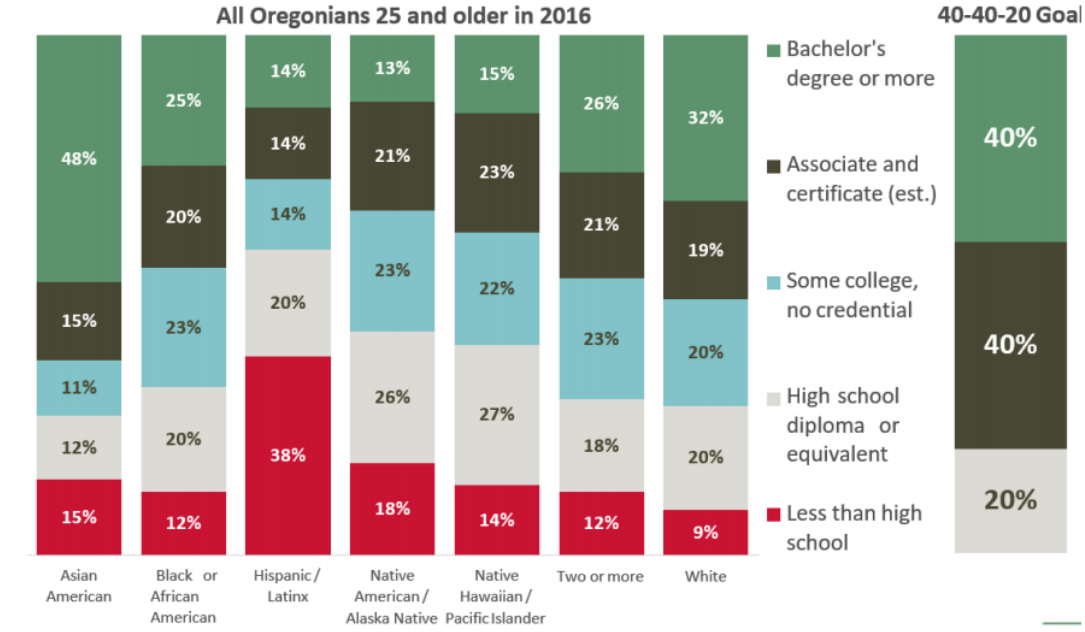
Source: National Equity Atlas, IPUMS USA

Educational attainment inequities = Inequitable recovery

There are significant opportunity gaps for educational attainment between White people and most people of color, particularly Black or African American, Hispanic/Latinx, Native American/Alaska Native, and Native Hawaiian/Pacific Islander (see Figure 3).[16] There is a direct, historic relationship between educational attainment and wages. The higher the educational attainment, the higher the wage. However, wage disparities by race and ethnicity exist even for individuals at the same education level (see Figure 4). Despite this inequity, educational attainment generally has positive impact on earning potential.[17]

Nationally, the wealth gap between Black and White Americans is as wide as it was in the 1960s. It would take the net worth of 11.5 Black households to equal the net worth of a typical White household.[15]

Figure 3. Oregon educational attainment by race/ethnicity, Oregon, age 25 and older



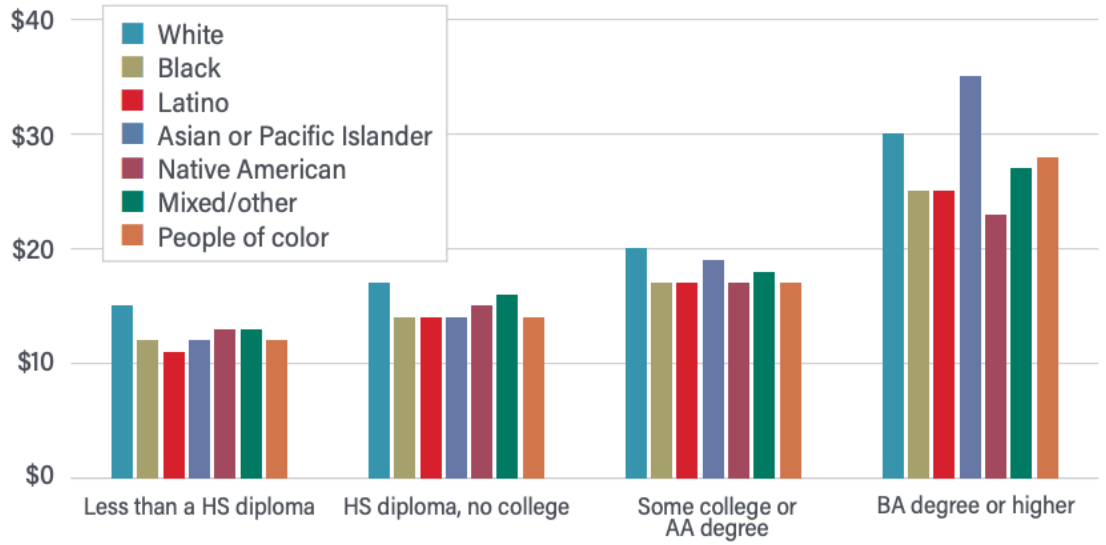
Source: Higher Education Coordinating Commission. (2018). *House Bill 2311: Establishing Oregon's Adult Attainment Goal*.

[15] "Pathways to Opportunity: Closing Opportunity Gaps Across Oregon." https://cdn.ymaws.com/www.ncwe.org/resource/resmgr/2020_conference/20_wed_workshop_slides/Wed_300_Trach_1_-_Kinder.pdf

[16] Higher Education Coordinating Commission. (2018). *House Bill 2311: Establishing Oregon's Adult Attainment Goal*. Salem, OR. https://www.oregon.gov/WorkforceBoard/board/Documents/8.1a%20ACTION%20ITEM%20State%20adult%20attainment%20goal%20(HB%202311,%202017).pdf

[17] National Skills Coalition. (2019). *The Roadmap for Racial Equity: An Imperative for Workforce Development Advocates, September 2019.* Washington, DC. https://www.nationalskillscoalition.org/resources/publications/file/Racial-Equity-Report_6x9_web.pdf

Figure 4. Median hourly wage by race/ethnicity and educational attainment, United States, 2015



Source: National Skills Coalition. (2019). *The Roadmap for Racial Equity: An Imperative for Workforce Development Advocates*, September 2019.

New jobs will require more education, not less

According to the Georgetown Center on Education and the Workforce, nationally, 99 percent of jobs created during the last economic recovery went to workers with at least some postsecondary education.[19] In an AI-influenced recovery, this dynamic will likely continue to be the case for those entering the job market for the first time and for those who are being retrained.

Oregon recognizes the need for more education and continuing education through its establishment of a new Adult Education and Training Goal and through career pathways. Oregon's adult education and training goal is that by 2030, "300,000 additional adult Oregonians will earn a new degree, certificate, or credential valued in the workforce during that time. Because Oregon has substantial attainment gaps among minority, low income and rural Oregonians, the state will also commit to reducing those attainment gaps by half during the decade."[20]

Prior to the COVID-19 pandemic and recession, 448,000 adults 25 and older in Oregon were unemployed or working and making less than $15/hour without postsecondary credentials; this number is equivalent to more than nine years of Oregon's high school graduating classes.[18]

[18] Portland Community College. (June 18, 2020). "Oregon's Community College Step (SNAP 50/50) Consortia COVID-19 Response." https://snaptoskills.fns.usda.gov/sites/default/files/2020-06/Final%20SNAP%20ET%20CVD%2019%20Webinar%2006.18.20.pdf

[19] Carnevale, Anthony P., Tamara Jayasundera, and Artem Gulish. (2016). *America's Divided Recovery: College Haves and Have-Nots, 2016*. Center on Education and the Workforce, Georgetown University. Washington, DC. https://cew.georgetown.edu/cew-reports/americas-divided-recovery/

[20] Oregon Postsecondary Education and Training Goals, https://www.oregon.gov/highered/about/Pages/state-goals.aspx

Implications for low-skill and low-income adults

According to the Program for International Assessment of Adult Competencies (PIACC),[22] the United States has more than 36 million adults at the lowest level of English literacy, with a high percentage of this population belonging to communities of color. These and other achievement and educational attainment levels place a significant percentage of our nation at high risk of being left behind by an AI-oriented recovery. Indeed, current unemployment figures show this disturbing and inequitable trend.[23]

A 2019 GAO study found that, nationally, almost 2 million college students who were potentially eligible for SNAP in 2016 did not report receiving benefits.[21]

Postsecondary education is challenging on its own, but today's student faces significant barriers that must be overcome to complete a certificate or degree program. In Oregon, roughly half of postsecondary students face housing and food insecurity (see Figure 5).

Figure 5. Basic needs insecurity at community colleges

#REALCOLLEGE	Community Colleges (2015-2019)	Oregon's Community Colleges (2019)
Food Insecurity	42-56%	41%
Housing Insecurity	46-60%	52%
Homelessness	12-18%	20%

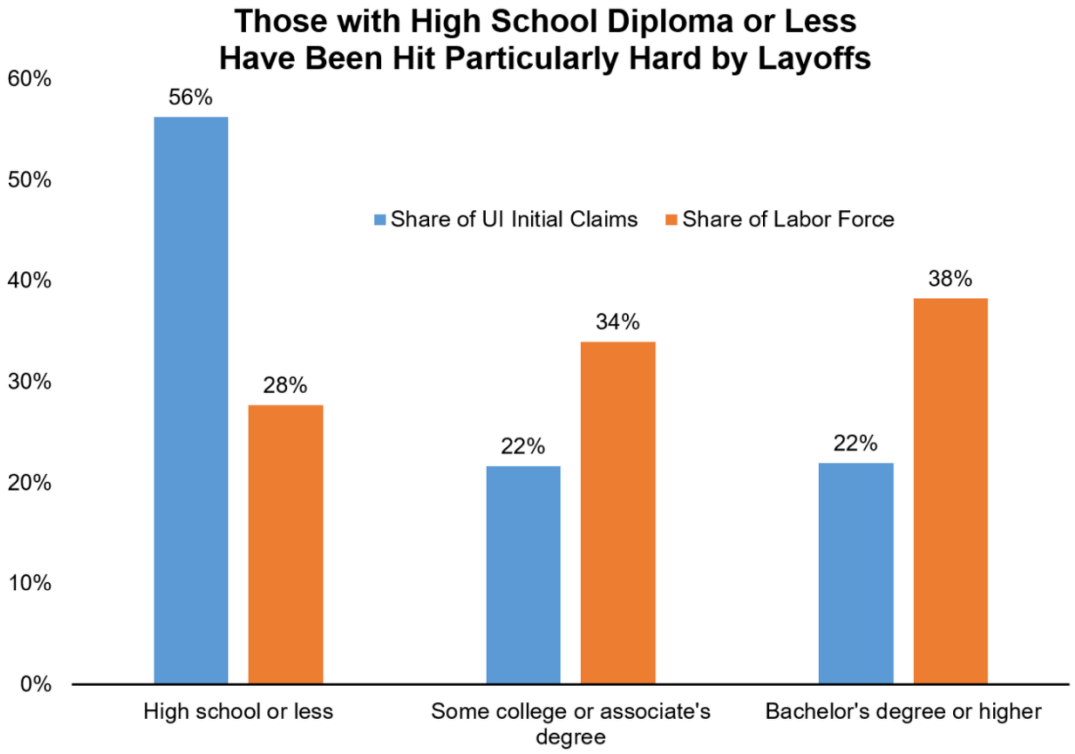
Data source: The Hope Center. (2020). Oregon Community Colleges, #RealCollege Survey.

Governor Brown's equity framework

All of these inequities have been exacerbated by the COVID-19 pandemic. Job losses due to the COVID-19 pandemic have been more severe for people of color, low-skill individuals, and low-income populations. Oregon Governor Kate Brown's office issued the State of Oregon Equity Framework in COVID-19 Response and Recovery to address these and other issues during the recovery.[24]

[21] Government Accountability Office. (January 9, 2019). *Food Insecurity: Better Information Could Help Eligible College Students Access Federal Food Assistance Benefits.* GAO-19-95: Published: Dec 21, 2018. https://www.gao.gov/assets/700/696254.pdf
[22] National Center for Education Statistics. (2018). "Program for the International Assessment of Adult Competencies." https://nces.ed.gov/surveys/piaac/
[23] NCES. (2020). "Employment and Unemployment Rates by Educational Attainment." https://nces.ed.gov/programs/coe/indicator_cbc.asp
[24] Office of Governor Kate Brown. (2020). *State of Oregon Equity Framework in COVID-19 Response and Recovery.* Salem, OR.

Figure 6. The COVID-19 pandemic exacerbates inequities: Initial Unemployment Insurance claims processed in the 12 weeks ending June 6, 2020



Source: Runberg, Damon. (June 11, 2020). "Who Are the COVID-19 Unemployed in Oregon?" Oregon Employment Department.

Worker retraining

European Union member states see "developing the skills necessary to work in AI and upskilling the workforce to become fit for the AI-led transformation" as a priority.[25] A recent white paper includes a recommendation to support networks of postsecondary institutions to recruit and retain the best educators and scientists to create "world-leading" postsecondary programs. It also recognizes that workers and employers directly affected by the design and use of AI systems in the workplace may need additional social partners to ensure a human-centered approach to AI at work. The current and future AI transformation of society in the United States is similar in scope,[26] and states must have strategies to help them lead.

The 2018 Oregon Talent Assessment called out the scope and pace of technological progress as a big question mark but acknowledged further disruption and transformation in the nature of jobs.

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https://www.oregon.gov/gov/policy/Documents/EquityFrameworkCovid19_2020.pdf

[25] European Commission. (2020). *White Paper: On Artificial Intelligence – A European Approach to Excellence and Trust.* Brussels, Belgium. https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

[26] Marr, Bernard. (2020). "What's the Impact of Artificial Intelligence and Technology on Society." *Forbes*, March 9, 2020. https://www.forbes.com/sites/bernardmarr/2020/03/09/whats-the-impact-of-artificial-intelligence-and-technology-on-society/#262eee713098

Specifically, AI was called out as a driver of disruption and examples given of AI-enabled technology outperforming human labor at higher points on the skill ladder (e.g., disease diagnosis, creative writing, clothing design). The 2018 Assessment recommended close monitoring of these trends and recognized that occupations that required a mix of high social and high math skills (some AI-related occupations, among others) grew at the fastest rate.

The 2020 Talent Assessment update observed that "the precise pace of technology's progress may be unclear, but most observers agree that advances in robotics and artificial intelligence will disrupt occupations and demand that workers continuously upgrade their skills throughout their careers." The update also acknowledged significant current and future growth for AI-related occupations. A key finding of the 2020 Assessment was that training for the work of the future will require an advanced ability to certify skills and redesign training. The report strongly recommended that Oregon stay on the frontier of that initiative. One potential avenue is the continued growth and evolution of apprenticeship programs in Oregon. A recent paper recommended that information technology be among the broad set of industry sectors involved in expanding apprenticeships.[27]

Worker retraining, like so many things, is further challenged by the COVID-19 pandemic. In the aftermath of the pandemic, successful programs will need to be human-centered[28] and provide an array of supporting services and resources in addition to training.

A recent report by ECONorthwest for the WTDB agreed that the COVID-19 crisis creates an opportunity to accelerate progress on solutions being human-centered and also recommended that solutions be tailored to differences in geographies across Oregon. The report suggested expanding apprenticeships as one effective solution.[29] ECONorthwest also suggested that there was an opportunity during the pandemic's immediate aftermath to leverage the proliferation of online, self-directed training tools to help unemployed and underemployed workers build general skills.

Finally, business, education, workforce, government, nonprofit, and other thought leaders from around the state gathered in mid-2020 for roundtable conversations about the effects of the COVID-19 pandemic on Oregon's workforce.[30] During these meetings, hosted in conjunction with the Oregon Business Council, many participants commented on the need for education and training systems and programs to adapt to the new conditions resulting from the pandemic and its aftermath. Workforce and education systems must be better aligned and better resourced for Oregon to continue to be successful.

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[27] Lerman, Robert I. (2020). *Stimulating Apprenticeship in Oregon Now and For the Future, Robert I. Lerman*. Urban Institute. Washington, DC. https://www.oregon.gov/workforceboard/talent/Documents/201019%20-%20Stimulating%20apprenticeships%20in%20Oregon.pdf

[28] Conley, David T. (2020). *Issue Brief: The Human Development Side of Economic Recovery in Oregon*. EdImagine. Portland, OR. https://www.oregon.gov/workforceboard/talent/Documents/Conley_Issue%20brief-v2-final.pdf

[29] ECONorthwest. (2020). *Effects of Social Distancing on Oregon's Leisure and Hospitality Workers*. Portland, OR. https://www.oregon.gov/workforceboard/talent/Documents/Social%20Distancing%20Effects%20Report_09_09_2020.pdf

[30] Summary of Workforce Conversations in 2020 with Business, Education, Workforce, Government, Nonprofit, and Thought Leaders During the Coronavirus Pandemic. Portland, OR. https://www.oregon.gov/workforceboard/talent/Documents/Workforce%20Conversations%20Summary_Final.pdf

ETHICAL IMPLICATIONS AND CONSIDERATIONS

In this section, Helen Edwards of Sonder Studio provides insight into the ethical implications and considerations associated with AI that our society needs to be prepared to discuss. The risk of growing inequality and wealth disparities will increase without timely and effective public policy.

Developing a workforce that is skilled, fluent, and confident in designing ethical AI is a future-proof investment opportunity. AI raises ethical considerations about many topics, including privacy, bias, fairness, equality, justice, and explainability. But along with these considerations come opportunities for new skill development and inclusion of non-technical specialties.

AI is able to find patterns, edge cases, and counter-intuitive outcomes. It is immensely powerful, and can provide a platform for progress. However, there is overwhelming evidence of its ability to harm when not used wisely. Algorithmic discrimination and AI-generated bias are very real problems that can be difficult to detect and remedy.

Increasingly, many academics, activists, technologists, lawyers, and designers are confronting bias and attempting to understand, expose, and mitigate it. There is a huge opportunity for career and skill development focused on "translation mechanisms" between the purely technical activities of AI and the rest of the ecosystem. These include design, ethics, market research, and entrepreneurial developments.

Bias in AI has many causes, but two categories are particularly important. The first is historical human bias which is reflected in a dataset. When this is used to train AI, the AI will exhibit the same bias. The second major source of bias is representation of particular groups in the data.

AI will learn to predict things about some groups better than others. Many social and economic factors affect people's representation in datasets. This creates opportunities for people of different backgrounds to help determine the use of AI because dealing with bias is not solely a technical challenge. People use a variety of strategies when dealing with AI bias and harm from AI systems.

New technical tools are being developed that help with debiasing, fairness testing, and documentation, as well as new processes for enabling broader, human-centered decisions.

Human-centered AI design is one such emerging practice and embraces the goal of making better AI. People who work in the area generally value putting humans first, with the belief that AI should serve humans, rather than humans being servants of the machines. Human-centered AI design practices and ethical AI design are being researched and refined as more people work with AI. This development means there are many other skills sets required in data science and AI that can enable better AI - visualization, explainable AI, data science ethics, as well as developing new tools and practices for involving others in decisions.

There are certain applications where AI can propagate racial and gender bias in ways that are particularly concerning from the perspective of advancing equality and inclusion. Facial recognition and automated hiring systems are two good examples of technologies where historical discrimination can be difficult to avoid.

Human bias in recruitment is a huge problem that denies millions a fair and equitable chance to prove themselves. AI has a role to play in solving this problem by efficiently sorting desirable candidates, predicting those who are most likely to succeed, reducing the impact of human prejudice and unconscious bias, and screening people through AI-interview processes.

One of the biggest problems with this process of AI screening is that the science is not keeping up. "Academic research has been unable to keep pace with rapidly evolving technology, allowing vendors to push the boundaries of assessments without rigorous independent research," say researchers from Cornell and Microsoft in a recent paper.[31] While the intent is good, data are lacking on whether AI is improving recruitment diversity and fairness or introducing new sources of bias, which are then applied at scale.

The COVID-19 pandemic is accelerating the adoption of AI-powered systems to recruit, evaluate, track, and onboard employees. Employers are "panic-buying"[32] automated onboarding and monitoring systems. For example, Amazon has used data-driven technology to on-board 1,700 staff in a day. Serco has cut the time it takes to hire a worker from 4 weeks to 4 days. Many decisions will be hard-wired into the datasets of the future. Human decisions about how AI systems are designed and deployed will shape access to work for years to come.

Facial recognition technology is another prime example. Facial recognition technology is not only powerful but also inexpensive and easy to deploy. People want to use it for valuable reasons—personalized shopping experiences, reduced friction at store check-out, and providing better experiences for travelers. The required level of technical expertise is not high. Oregon became the testing ground for Amazon's Rekognition technology and how it became so pervasive, so rapidly. It is "easy to activate, requires no major technical infrastructure, and is offered to virtually anyone at bargain-barrel prices. Washington County spent about $700 to upload its first big haul of photos, and now, for all its searches, pays about $7 a month."[33]

But facial recognition is facing a backlash—for numerous reasons. Recently Amazon, IBM, and Microsoft announced various levels of pull-back from selling the technology. Facial recognition's unique technology raises significant privacy and surveillance concerns. And researchers like Joy Buolamwini, Timnit Gebru, and Deborah Raji have demonstrated that these technologies can come with racial and gender biases that are difficult to correct.

This raises a legitimate question for regulators: Does a technology this powerful need better guardrails defined in specific legal requirements, rather than simply relying on companies to make these choices?

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[31] Edwards, Helen. (2019). "Why is HR so gullible?" https://artificiality.substack.com/p/why-is-hr-so-gullible

[32] Graham, Logan, Abigail Gilbert, Joshua Simons, Anna Thomas, and Helen Mountfield. (2020). *Artificial Intelligence in Hiring: Assessing Impacts on Equality, April 2020.* Institute for the Future of Work. https://static1.squarespace.com/static/5aa269bbd274cb0df1e696c8/t/5ea701fd39af0e44164abfce/1588003365458/IFOW-Assessing+impacts+on+equality.pdf

[33] Harwell, Drew. (2020). "Oregon Became a Testing Ground for Amazon's Facial-Recognition Policing. But What if Rekognition Gets It Wrong?" *The Washington Post*, April 30, 2019. https://www.washingtonpost.com/technology/2019/04/30/amazons-facial-recognition-technology-is-supercharging-local-police/

AI also challenges the legal landscape. Tech giants, antitrust, privacy, surveillance, ad micro-targeting, discrimination, and bias are all hot topics. While new laws are likely required, it's not clear when, how, and to what extent new regulations will be introduced to deal with the challenges of AI.

Algorithmic decision-making that results in discrimination or disparate treatment, that is done without notice, or in ways that humans cannot understand and explain, is increasingly being investigated. The legal system in the US is "in flux" as many foundational legal principles break down in a world powered by intelligent, autonomous systems where the tradeoff between fairness and accuracy is difficult to determine. There is an opportunity for a specialty legal educational initiative on law in the age of AI.

AI increasingly substitutes for, or enhances, human decision-making. Because AI learns and acts on its own and changes as new data about the world are made available, it can help guide humans in ways that traditional technology does not. This interactivity and shared agency have existential consequences for humans.

For entrepreneurs, AI brings additional complexity and risk, so there is an opportunity to tailor programs for entrepreneurs to the unique requirements of AI. Oregon is leading in many applied AI developments. For example, an Oregon-based startup, Shift, uses virtual reality and AI to teach people about human unconscious bias and help them make changes to their behavior. Leveraging the scale of AI to train more people and change how we propagate bias is powerful. It borrows an idea from self-driving cars, where new knowledge can be updated and uploaded faster and at scale.

These issues have thrown philosophy and technology ethics into the spotlight. Many companies are employing ethicists to help their technologists and product managers make more ethical decisions. This is often an ambiguous area and demands an increase of people with the skills to help navigate complex societal and ethical decisions in the context of product and software development. At its core, AI gives us insight into how human minds work. Humans evolved ways of thinking under constrained resources of energy and time. But, as a society, we need to have the capacity to and be ready to discuss the biases that AI will inevitably reveal.

AI STRATEGIES AND OUTLOOK

Many countries have laid out policies and strategies to prepare and adapt to an AI-driven world, sensing the urgency, pervasiveness, and far-reaching impact of the technology. The Organization for Economic Co-operation and Development (OECD) has created the OECD AI Policy Observatory,[34] detailing over 300 AI policies from over 60 countries. The Future of Life Institute, an international policy nonprofit founded by Stephen Hawking, summarizes AI strategies[35] from major world economic regions, including those highlighted below:

European Union: 25 EU member countries signed a "Declaration of Cooperation on Artificial Intelligence"[36] focusing on three goals: (1) increase technological and industrial capacity for AI adoption

[34] Organisation for Economic Co-operation and Development (OECD). (2020). "OECD AI Policy Observatory." https://oecd.ai/
[35] Future for Life Institute. (2020). "National and International AI Strategies." https://futureoflife.org/national-international-ai-strategies/
[36] European Commission. (April 10, 2018). *Declaration of Cooperation on Artificial Intelligence*. Brussels, Belgium. https://ec.europa.eu/digital-single-market/en/news/eu-member-states-sign-cooperate-artificial-intelligence

by public and private sectors; (2) prepare Europeans for the inevitable socio-economic changes; and (3) ensure that an appropriate ethical and legal framework is in place. An expert group established by the EU Commission published ethics guidelines with seven key requirements that AI systems should meet to be deemed trustworthy.[37]

Finland: The Ministry of Economic Affairs and Employment has published two reports. The first, from 2017, is titled "Finland's Age of Artificial Intelligence"[38] and includes eight broad proposals; the second was published in June 2018[39] and offers many AI policy recommendations on economics, employment, labor market, education, skills management, and ethics. Finland has launched a free six-week online course in AI[40] to educate its citizens and has made the course accessible for anyone in the world to take it at no cost.

Canada: A five-year plan to invest US$90 million in AI research and talent was outlined in the 2017 federal budget and included four goals: (1) increase the number of AI researchers and skilled graduates; (2) establish interconnected nodes of AI research excellence in Edmonton, Montreal, and Toronto-Waterloo; (3) develop thought leadership on the economic, ethical, policy, and legal implications of AI; and (4) support the national research community on AI.

China: The "New Generation Artificial Intelligence Development Plan"[41] outlines China's strategy to build a domestic AI industry worth nearly US$150 billion by 2030 via a three-stage plan: (1) bring China's AI industry "in-line" with competitors now; (2) become "world-leading" in some AI fields by 2025; and (3) be the primary center for AI innovation in the world by 2030. The plan is the most comprehensive of all national AI strategies, with goals for R&D, industrialization, talent development, education and skills acquisition, standard setting and regulations, ethical norms, and security. China is close to achieving the first stage of the plan through (1) developing intelligent and networked products such as vehicles, service robots, and identification systems; (2) developing AI's support system, including intelligent sensors and neural network chips; (3) developing intelligent manufacturing; and (4) investing in industry training resources, standards testing, and cybersecurity.

United States: The "National AI R&D Strategic Plan: 2019 Update" established eight strategic priorities:[42]

1. "*Make long-term investments in AI research.* Prioritize investments in the next generation of AI that will drive discovery and insight and enable the United States to remain a world leader in AI.

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[37] European Commission. (April 8, 2019). "Ethics Guidelines for Trustworthy AI." Brussels, Belgium. https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai

[38] Ministry of Economic Affairs and Employment. (2017). "Finland's Age of Artificial Intelligence: Turning Finland into a Leading Country in the Application of Artificial Intelligence, Objective and Recommendations for Measures." *Publications of the Ministry of Economic Affairs and Employment,* 47/2017. Helsinki, Finland. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160391/TEMrap_47_2017_verkkojulkaisu.pdf

[39] Ministry of Economic Affairs and Employment. (2018). "Work in the Age of Artificial Intelligence: Four Perspectives on the Economy, Employment, Skills, and Ethics." *Ministry of Economic Affairs and Employment*, 21/2018. Helsinki, Finland. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160980/TEMjul_21_2018_Work_in_the_age.pdf

[40] Elements of AI. (2020). "Finland's Free Online AI Course: Elements of AI." https://www.elementsofai.com/

[41] Future of Life Institute. (2017). "AI Policy – China, July 2017." Cambridge, MA. https://futureoflife.org/ai-policy-china/

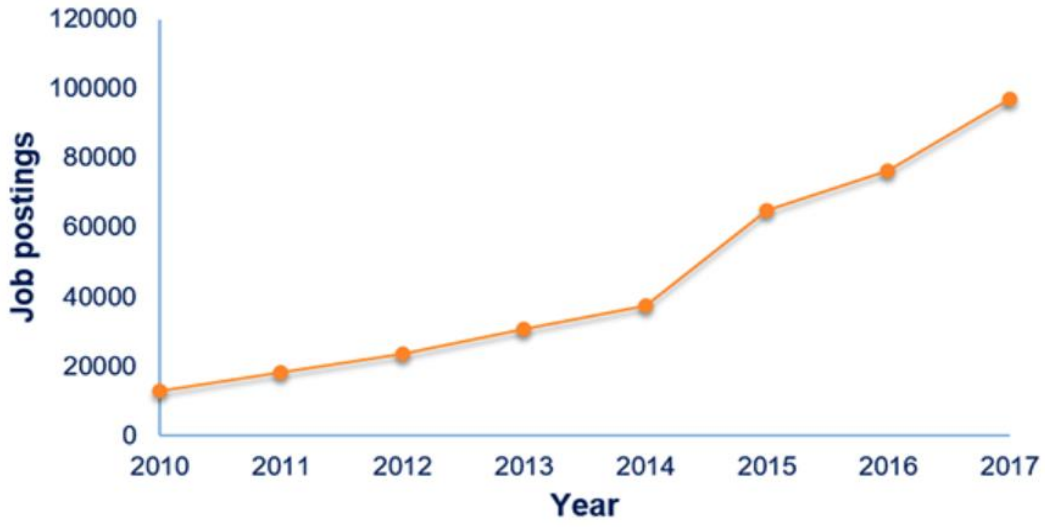
[42] Executive Office of the President of the United States, Select Committee on Artificial Intelligence. (June 2019). *The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update*. National Science & Technology Council, Washington, DC. https://www.whitehouse.gov/wp-content/uploads/2019/06/National-AI-Research-and-Development-Strategic-Plan-2019-Update-June-2019.pdf

2. *Develop effective methods for human-AI collaboration.* Increase understanding of how to create AI systems that effectively complement and augment human capabilities.
3. *Understand and address the ethical, legal, and societal implications of AI.* Research AI systems that incorporate ethical, legal, and societal concerns through technical mechanisms.
4. *Ensure the safety and security of AI systems.* Advance knowledge of how to design AI systems that are reliable, dependable, safe, and trustworthy.
5. *Develop shared public datasets and environments for AI training and testing.* Develop and enable access to high-quality datasets and environments, as well as to testing and training resources.
6. *Measure and evaluate AI technologies through standards and benchmarks.* Develop a broad spectrum of evaluative techniques for AI, including technical standards and benchmarks.
7. *Better understand the national AI R&D workforce needs*. Improve opportunities for R&D workforce development to strategically foster an AI-ready workforce.
8. *Expand public-private partnerships to accelerate advances in AI.* Promote opportunities for sustained investment in AI R&D and for transitioning advances into practical capabilities, in collaboration with academia, industry, international partners, and other non-Federal entities."

AI labor market outlook

In recent years, the field of AI has grown exponentially and experts in the field predict that this trend will continue. The job site LinkedIn's annual forecast of the fastest-growing jobs in 2020 ranked AI-related positions in first, second, *and* third place, with the number one job of AI Specialist having grown 74 percent annually over the past four years. A different job site, Indeed, stated that the job of Machine Learning Engineer grew 344 percent from 2015 to 2018. Figure 7, from the jobs site Burning Glass, also indicates this massive growth in the field.

Figure 7. Job postings in artificial intelligence, United States, 2010-2017



Source: Burning Glass Technologies. (January 11, 2018). *Artificial Intelligence Hiring Expands Beyond Tech Sector*.

This rapid growth is problematic. For many years, businesses using AI have stated that the lack of skilled AI practitioners is the most important barrier to developing and deploying the technology. A survey from the Chinese technology company TenCent estimated that millions of AI jobs are available

worldwide, but the AI experts actually capable of doing those jobs number only 300,000. In response to a survey about the barriers organizations face in adopting AI, nearly half of respondents (45%) reported that their organizations lack the skilled personnel needed to implement AI.[43]

The consequences of the COVID-19 pandemic will only exacerbate this issue. As more and more businesses and organizations shift from in-person to remote services, traditional solutions like work-from-home or outsourcing will be heavily utilized. However, providing remote services is also a paradigm use-case for AI; there will likely be an explosion of demand for AI services in the coming years. Due to this convergence of events, the demand for AI talent will evolve from a bottleneck into a crisis.

The COVID-19 pandemic will affect AI development in other ways as well. Many of the industries hardest hit by the pandemic are industries most vulnerable to job changes through AI, which is all about mimicking human intelligence, decisions, and actions. These businesses are also vulnerable to job reductions through increased automation, which focuses on streamlining repetitive and instructive tasks. This dynamic is, in part, described in the following chart from the Brookings Institute.

Table 1. Current-task automation potential

Occupation group	Automation potential
Food Preparation and Service	81%
Production Operations	79%
Office and Administrative Support	60%
Farming, Fishing, and Forestry	56%
Transportation and Material Moving	55%
Construction and Extraction	50%

Source: Metropolitan Policy Program. (January 2019). *Automation and Artificial Intelligence: How machines are affecting people and places.*

YOUTH AND AI

A less-discussed topic surrounding AI is that the jobs generally held by students are low-wage and low-skill—the very jobs that are at the highest risk of being replaced by AI. Students hold jobs not just for income, but in order to gain life experience, social skills, and technical skills.

Drawing from previous analyses and results from studies done by Intelligensia.ai, McKinsey Global Institute, and Oxford University, Chloe Leis, a student at Redmond Proficiency Academy, conducted a research project that included surveying students from ages 14 to 24 attending high school or college in Central Oregon.[44]

[43] MIT Technology Review. (May 28, 2019.) Digital challenges: Overcoming barriers to AI adoption." Survey of 112 respondents at EmTech Digital conference. https://www.technologyreview.com/2019/05/28/135184/digital-challenges-overcoming-barriers-to-ai-adoption/

[44] Leis, Chloe. (2020). *Artificial Intelligence, Automation and Employment: A View from an Oregon High School Senior, Class of*

Chloe found that many students' jobs are at risk of automation: 31.0 percent are highly augmentable according to Intellgentsia.ai research; 72.4 percent are in high-risk industries according to Oxford University; and the average probability of automation for all respondents' jobs was 75.8 percent according to Oxford University statistics.

These numbers are concerning, as is the misunderstanding of technological unemployment. Expectations can vary from high risk of replacement to no threat at all, where people do not believe it is possible for a machine to do a series of complex tasks. This misunderstanding played out in Chloe's survey as some responses suggest that students think machines cannot perform "hands on work" or "manually put parts together." Chloe also notes that machines are advancing to the point that they are capable of doing repetitive and complex physical tasks.

Educating youth about these issues and raising awareness of technological advancements and their ramifications can help address some of these concerns. Chloe suggests there be an emphasis on educating youth about AI and robotics early. She notes that "it is vital that we properly prepare the next generation for a workforce where AI and mobile robotics are integrated into most jobs."[45]

Chloe's research indicates that there could be valuable investment opportunities in initiatives such as:

- "Training frontline workers in how to identify the opportunities for automation that augments their skills and increases efficiency, productivity, and value;
- Training young people in skills that machines cannot compete in, as well as design, ethics, and other non-technical or coding aspects of AI and robotics;
- Focusing more education on entrepreneurship and innovation so more people can participate in the automation economy."

She concludes, "We must prepare the next generation for the technology-ridden workforce they will face via an emphasis on the skills that will become vital to human employment in the next decade and beyond."[46]

SECTOR-BASED IMPACT

Many technologies influence work and will continue to do so at a rapid pace. For example, banks are using anti-money laundering algorithms and call centers are using chatbots for customer service. Companies in a number of sectors are "[harnessing] AI's power to increase operational efficiency and make faster, more informed decisions. And of course, the more that AI influences customer expectations, the greater the impact it will have on the future of work in the Fourth Industrial Revolution."[47]

2020. Redmond Proficiency Academy. https://www.oregon.gov/workforceboard/board/Documents/AI%2014-24%20For%20Oregon%20AI%20WF%20taskforce%20-%20Google%20Docs.pdf

[45] Ibid.

[46] Ibid.

[47] Daugherty, Paul. (April 29, 2020). *What's the Future of Work in the Age of AI?* Salesforce. https://www.salesforce.com/ap/blog/2020/04/future-of-work-in-the-age-of-ai.html

Hiring managers expect AI to make waves in workplace productivity and innovation. They also recognize that this shift will precipitate new and expanded employee skill sets, both in terms of hard skills (e.g., data analysis and software development) and soft skills (e.g., collaboration and creative thinking). Nearly 60 percent of hiring managers say that AI will have a substantial or transformational impact on the types of skills their companies need.[48]

How are companies preparing their workforce for advancements in technology? About 88 percent of hiring managers say that formalized retraining programs to evolve incumbent employee skill sets will be crucial in the years ahead. To future-proof their workforce and diversify their talent pools, managers are exploring apprenticeships and training programs for non-college-educated talent. About 66 percent of hiring managers believe workforce development programs will boost their company's preparedness for future disruptions or innovations. The Fourth Industrial Revolution demands new, innovative approaches to workforce development.[49]

What are Oregon companies and employers thinking about and planning for with regard to AI? The following sections are organized by key sectors in Oregon's economy: agriculture, construction, energy, food and beverage, forest products, healthcare, manufacturing, professional business services, technology, transportation, and government.

AGRICULTURE[50]

The Oregon agriculture industry, with over 220 recognized commodities and valued at more than $5 billion annually, is in the top ten nationally for exports of many crops including blueberries, hazelnuts, Christmas trees, and grass seed. There are more than 34,600 Oregon farms and ranches occupying about 16.4 million acres. The average farm size is 474 acres, with about 97 percent of Oregon's farms and ranches being family owned and operated. Because 80 percent of Oregon's agriculture companies produce exports, these family-owned small businesses compete in the national and international commodity markets. The "ag" industry has a unique challenge in that they have a fixed amount of land to work with, but farmers are participating in a global commodity economy with little control over the price of their crop and the cost of inputs. This is the ultimate lesson in maximizing scarce resources, added on top of the challenges posed by unpredictable weather patterns.

Like all industries, agriculture is beginning to leverage AI and predictive analytics—pure data solutions for things like yield prediction, price forecasting, and planting plans, and hardware-oriented solutions like weed recognition and seed cleaning. Agriculture is more than just the farmers. There is a network of agronomy companies that provide consulting services for a variety of farming practices (e.g., types of crops, soil management, and pest control). There are also logistics such as transportation, cold storage, permitting/certifications, food processors, and equipment manufacturers. Oregon's comparative advantage lies in having all aspects of the agricultural supply chain, so improving one aspect of the ag industry will produce positive ripple effects.

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[48] Ibid.
[49] Salesforce. (2020). *The Future of Workforce Development: Insights from 750 Business Leaders on How Technology Is Transforming the Future of Work.* https://c1.sfdcstatic.com/content/dam/web/en_us/www/documents/research/market/future-of-workforce-development-salesforce-research.pdf
[50] Economic Development, City of Independence | Summer 2020 (unless otherwise noted).

Data analytics is already being applied, and AI is bringing decisions into real-time practice. People are doing yield and pricing predictions now but AI could create a real-time marketplace for commodities, enabling farmers to sell when the price is best and maximize profits. With the sensors being used to monitor crops through the supply chain, AI could enable better "just-in-time" delivery of fresh food, enhancing quality and potentially price, while reducing wastage. AI could also monitor the supply chain and raise alerts about situations that could result in spoilage of product, ensuring that more product gets from the farm to the end user in a timely manner. Similarly, there's growing consumer interest in locally sourced food and knowing your food's origin. AI can enable the kind of aggregation and route planning that would afford multiple smaller growers the ability to serve a grocery store or larger restaurant chain. This dynamic opens new markets for the growers and meets consumer demand. AI could even be used to optimize storage layouts and workflow processes in cold storage facilities to maximize cooling and increase energy efficiency.

AI could help a farmer make decisions by offering predictive models for growth, yields, and pricing on different crop mixes. A farmer could utilize AI to prioritize work, identifying which parts of a field require immediate attention in order to maximize the benefits of intervention. AI could help build a market for carbon trading within agriculture, valuing and selling the carbon sequestration of various crops and farming practices, which helps the farmer diversify their revenue streams and make more per acre. AI can also assist with the weather by providing better microclimate predictions. AI can leverage past data to create real-time alerts for freezes, wind, and other problem weather conditions. Right now, these kinds of predictive decision-making processes are clustered with the agronomy companies and offered as a service to farmers.

On the hardware side, AI can be applied with robotics in automation and labor saving like recognizing and automating weed spraying as a spray rig rolls through a field, saving staff time and money (the cost of herbicide) while reducing the impact on the environment. As a preventative measure, AI can recognize pests and alert farmers as soon as they migrate onto the farm. By pairing a pest recognition system with predictions on the likelihood or severity of a pest's presence in an upcoming growing year, efficiency and effectiveness of pest management is increased. Because grass seed is valued by how clean (i.e., free of weeds) it is, AI can be integrated into an automated cleaning system to better identify and remove undesirable seeds from grass seed, increasing the seed's value per pound.

Ag provides a significant opportunity for AI because the industry already does not have enough labor. There is a big gap in terms of work that needs to be done and people who are willing and able to do it. AI can help fill this gap. In addition, there is an opportunity to model how existing workers can be trained to run the automation that will end up performing their existing jobs.

There is a more urgent necessity for innovative, cost-effective, and automated technological solutions in the food production process.[51] On the global scene, indoor farming innovation is attracting great interest for the opportunity to guarantee results in terms both of quantity and quality, and many initiatives have been launched to find the most effective technological and operational solutions. The emergency produced by the COVID-19 pandemic has also underlined the need to reduce reliance on the human presence in the food production process, and has made it clear that robotized automation in

[51] Campagnoli, Raffaella. (April 16, 2020). "Competitive Agility: How the Hospitality Industry Can Win Admist New Challenges." *Entrepreneur*. https://www.entrepreneur.com/article/349354

this industry is no longer an alternative, but a necessity.[52]

CONSTRUCTION[53]

Construction has historically been slow in adopting new technologies, but that is starting to change, according to Associated General Contractors. AI technology is mainly being utilized in creating efficiencies in scheduling, project planning, and logistics. For example, Oregon State University tracked movement of aggregate loaders at a quarry to find ways to maximize logistics. Associated General Contractors will continue to track AI developments and find ways for members to learn about and take advantage of new technologies.

A June 2020 *Forbes* magazine article adds:

> "In recent years, construction companies have increasingly started using AI in a range of ways to make construction more efficient and innovative. From optimizing work schedules to improving workplace safety to keeping a secure watch on construction facilities, AI in the construction industry is already proving its value.
>
> Construction managers have been finding value with AI and cognitive technologies to help automate many of the mundane but essential tasks to running their operations. They are finding AI helpful with scheduling related tasks in order to prevent delays, conflicts, and other issues. This is both on the staff level of scheduling and on the project and materials side.
>
> For small scale projects humans might be able to manage complicated construction schedules and processes manually. However, large scale, multi-year projects require the coordination of many complicated tasks and moving parts such as designs and blueprints, permits, and unexpected delays and changes that quickly get out of control for humans to manage without the assistance of technology."[54]

ENERGY[55]

AI has a significant role in the electric energy sector of the economy. Electric companies have a mission to provide safe, reliable, secure, and increasingly clean energy to customers, with excellent service at an affordable price. To achieve this mission, AI is being used to interrogate massive amounts of data collected by electric companies to identify ways to improve the overall performance of the business from both an efficiency and service perspective. AI technology is used to:

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[52] Campagnoli, Raffaella. (June 7, 2020). "Building New Ecosystems: The Food Tech Revolution Is Here." *Entrepreneur.* https://www.entrepreneur.com/article/351562
[53] Oregon Associated General Contractors (unless otherwise noted).
[54] Walch, Kathleen. (June 6, 2020). AI Transforming the Construction Industry. *Forbes.* https://www.forbes.com/sites/cognitiveworld/2020/06/06/ai-transforming-the-construction-industry/; Cognilytica. (June 26, 2019). "AI Today Podcast #95: AI Use Case Series – AI in Construction." https://www.cognilytica.com/2019/06/26/ai-today-podcast-95-ai-use-case-series-ai-in-construction/
[55] Portland General Electric (unless otherwise noted).

- Identify patterns or signatures of physical equipment to better predict end-of-life failures of generation, transmission, and distribution equipment to optimize timing of equipment replacements as well as to augment inspection programs.
- Evaluate customer usage data to identify potential customer demand reductions, customer on-site equipment problems, fraudulent transactions, local outages, neighborhood loading issues, penetration and impact of new customer technologies (e.g., solar, batteries, and electric vehicles), and other potential ways to improve the overall customer experience.
- Control technologies to enable a resilient and self-healing electric grid that operates autonomously to improve system reliability.
- Provide cyber and physical security technologies that operate autonomously to monitor, notify, and protect from unwanted intrusion or breach of critical operating control systems and facilities.

Harvard's Science in the News (SITN) offered an additional perspective, stating that "AI is also limiting the industry's environmental impact at a time when demand is steadily growing, our energy production portfolio is diversifying, and we are witnessing the ramifications of fossil fuel consumption on biodiversity, air quality, and quality of life."[56]

FOOD AND BEVERAGE[57]

AI may prove beneficial in numerous areas of the food and beverage industry. Manufacturing facilities are increasingly reliant on technology to safely achieve scale and remain cost competitive, especially in tight labor markets. In addition to the increasing reliance on technology, food processing can be relatively energy intensive, which makes it a prime candidate for an additional layer of intelligence to optimize usage. This shift toward manufacturing automation has resulted in highly advanced equipment that is not only executing orders, but also generating data that can be stored, analyzed, and used to improve decision-making.

A strong example of this technology is automated sorting. Many food processors rely on optical sorting technology to remove defects from food products. As crops are washed, trimmed, diced, and otherwise processed, this technology proves to be the most viable way to inspect high volumes of product and remove non-food material from the flow so that only good, safe products make it to the finished box or bag without requiring extensive human inspection. Manufacturers of this technology have already developed features that allow operators to improve yield by "sorting to grade" that enables the machine to allow more or fewer defects to pass through based on the defect load of the product it is inspecting and the required specification. But the information captured by these types of machines has the potential to also change decision-making both up and downstream in the process, if analyzed properly. This self-adjustment feature allows processors to recover more product, but the other information gathered by the sensors (e.g., color, density, defect rate, shape recognition) could provide operators with information or suggestions applicable to other parts of the process to improve total recovery and save cost.

[56] Wolfe, Franklin. (August 28, 2017). How Artificial Intelligence Will Revolutionize the Energy Industry, Harvard Graduate School of Arts and Sciences Science in the News. Harvard University. Cambridge, MA. http://sitn.hms.harvard.edu/flash/2017/artificial-intelligence-will-revolutionize-energy-industry/

[57] Boardman Foods (unless otherwise noted).

The data created on the processing side, in concert with AI, could also be a powerful tool on the agriculture side of food processing operations. With the proper IT infrastructure, the data generated in terms of recovery and quality could be linked to other crop attributes such as variety, grower, storage history, farming practices, crop treatment, weather events, harvest information, and others to facilitate conclusions about the impact of these variables on finished product quality.

Another sizable opportunity is AI's impact on energy and facility management. Similar to increasingly technologically advanced processing equipment, the compressors, pumps, fans, and other high-energy-use machines produce data via their controls systems that can be stored and analyzed to better guide optimization efforts and the prioritization of energy savings projects. It is well understood that variable speed drives can help facility managers save energy and cost through balancing output with demand, but powering the analysis of an organization's energy demand with AI could unlock additional opportunities to streamline operations, reduce energy intensity, and minimize the manufacturing carbon footprint. Along similar lines, the consummate analysis of electronic maintenance records, machine drive metrics, and information from other equipment sensors paired with AI could help facility managers plan maintenance efforts and make the best use of planned shutdowns so that unplanned downtime can be avoided and production crews can be as productive as possible.

FOREST PRODUCTS[58]

AI has had a definite impact on the current workforce in the wood products manufacturing sector and will only continue to grow as a part of this sector. As sawmills and plywood mills are automated, workforce dynamics are changing at an exponential rate. When AI is introduced into operations, this technology replaces labor with machines and robotics in many cases. This dynamic does not diminish overall labor needs but changes "who" is needed in operations. With more automation, robotics, and AI technology, a new demand is created within the workforce – skilled labor. More highly skilled and knowledgeable millwrights, electricians, programmers, and mechanics are the wave of workforce demand in the future. In Oregon, specifically with electricians, there is a statewide shortage of "plant electricians" that all industries are fighting to hire into their operations.

HEALTHCARE[59]

The COVID-19 pandemic laid bare the stresses on our healthcare system and jump-started both the implementation and consumer acceptance of AI in healthcare settings. AI has the promise to positively disrupt the three legs of healthcare: access, outcomes, and costs. Besides automated diagnosis, which is often cited as the most impactful application of AI, telemedicine, virtual nursing assistants, robot-assisted surgery, and administrative workflow assistance are among the applications through which can anticipate annual cost savings up to $150 billion by 2026.[60] Amid rising healthcare labor shortages, AI offers potential tools to healthcare workers that bridge our unmet physician and clinical demand.

A recent Market Insights Report from the American Hospital Association Center for Health Innovation noted that AI and machines can ease the burden on healthcare workers by reducing administrative

[58] Swanson Group (unless otherwise noted).
[59] Oregon Center for Nursing (unless otherwise noted).
[60] Accenture. (2017). *Artificial Intelligence: Healthcare's New Nervous System*. https://www.accenture.com/_acnmedia/pdf-49/accenture-health-artificial-intelligence.pdf

tasks and mining and processing medical information and patient records for faster and more accurate decisions.[61] Staff time opens up for tasks that only a human can do — problem solving, critical thinking, and having conversations with patients. In healthcare delivery, genomics, and digital medicine, AI will transform clinical decision-making with more-accurate and faster diagnosis and guidance on treatments for precision and personalized medicine.

This clinical decision support, coupled with data feeds from patients who monitor their health with apps, will create a data-rich environment for providers to focus more on prevention, health, and well-being. As a result, the workforce of the future will not only need people with technical skills, but also essential employability skills like communication, interpersonal connection, and teamwork to take full advantage of what AI gives them to do their jobs. If done right, AI can put the care back into healthcare with a renewed focus on personal interactions with patients — listening, empathizing, and educating.

Forward-looking healthcare leaders see AI as perhaps the most effective path to a more productive, more efficient, and higher-performing workforce. But realizing AI's full potential will require work on many fronts. It will take the collective effort of senior executives, health IT, operations, finance, clinicians, and employees as well as new expertise to successfully integrate AI into the daily management and operations of the healthcare workplace. Five years from now, patients may not see anything or anyone new when they go to the hospital. But they will benefit from an entirely new experience driven by an AI-enabled workforce.

The Market Insights Report entitled "AI and the Healthcare Workforce" states that "With AI as their new co-worker, staff will need to acquire new skill sets and competencies to take advantage of AI capabilities, and the educational pipeline needs to equip those entering the healthcare workforce with new skills. The healthcare employee of the future will need:

- "*Digital acumen* — the ability to work comfortably with AI in several areas, including entering and accessing data, using data in their workflows and incorporating data/insights into decision-making.
- *AI acumen* — a basic knowledge of how AI works and an understanding of why it's generating certain outcomes, conclusions or recommendations based on the data it's being fed.
- *Data appreciation* — a passion for protecting the privacy and security of patients' personal health information as it's used by AI in new and different ways and for consistently following the employer's data governance policies.
- *An open mind* — a willingness to see AI as a career opportunity rather a threat to job security, to collaboratively work with other disciplines like technologists, operations and clinicians to design effective AI models and to maintain an open spirit of inquiry that allows for the assessment of the effectiveness of AI tools with an eye toward maximizing their operational effectiveness.
- *Agility* — More than anything else, the attribute to bring to work every day will be agility. The pace of health care AI technological advancements is accelerating, and so will the adoption of those technologies by health care workplaces. They need a workforce that can roll with change, turn on a dime, and embrace a new AI model that creates more value."[62]

[61] American Hospital Association. (2020). "Market Insights: AI's Impact on Health Care." https://www.aha.org/center/emerging-issues/market-insights/ai

[62] American Hospital Association. (2020). "AI and the Health Care Workforce." https://www.aha.org/center/emerging-

AI will result in fewer and different types of clinicians who are focused on consultation and care for complex cases and provide the means to "elevate the human interactions at the heart of healthcare."[63]

As healthcare transitions to AI, individual clinicians and education systems may struggle to adjust. Additional discussions continue with how to ensure health equity and remove bias for underserved and vulnerable populations when using AI and other health technologies. However, the COVID-19 pandemic has created an opportunity to deploy more innovative solutions, including AI, to provide cost-effective and positive health outcomes.

MANUFACTURING[64]

Small and medium manufacturers are being left behind in the Fourth Industrial Revolution. AI is a difficult area for these companies. The resource and data infrastructure requirements are heavy, and attempting to build the required technology is costly. Most manufacturers do not have the necessary skills and knowledge in-house. To help address these issues, the Oregon Manufacturing Extension Partnership (OMEP) has been developing Industry 4.0 (I4.0) solutions for manufacturers in the areas of cobots, Internet of things, augmented reality, and cloud systems.[65] This work positioned OMEP to move into developing AI solutions that provide low-cost alternatives for AI implementation.

Some of the direct benefits of AI in manufacturing include:

- Cost reduction through predictive maintenance (PdM). PdM leads to less maintenance activity, which means lower labor costs and reduced inventory and materials wastage.
- Predicting Remaining Useful Life (RUL) – Knowing more about the behavior of machines and equipment leads to creating conditions that improve performance while maintaining machine health. Predicting RUL does away with "unpleasant surprises" that cause unplanned downtime.
- Improved supply chain management through efficient inventory management and a well-monitored and synchronized production flow.
- Improved quality control with actionable insights to constantly raise product quality.
- Improved human-robot collaboration leading to improved employee safety conditions and boosting overall efficiency.
- Consumer-focused manufacturing – being able to respond quickly to changes in market demand.

An Industry 4.0 system consists of a number of elements and phases that need to be configured to suit the manufacturer's needs:

- Historical data collection, live data capturing via sensors, data aggregation, and feature engineering
- Connectivity via communication protocols, routing and gateway devices, and integration with programmable logic controllers (PLCs)

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issues/market-insights/ai/ai-and-health-care-workforce

[63] Wolf, Jason A. (2019). Reframing Innovation and Technology for Healthcare: A Commitment to the Human Experience. *Patient Journal, 6*(2). DOI: 10.35680/2372-0247.1392

[64] Oregon Manufacturing Extension Partnership (OMEP) | June 2020 (unless otherwise noted).

[65] Fox, Aaron. (2020). "Why You Know More About Industry 4.0 Than You Think." https://www.omep.org/why-you-know-more-about-industry-4-0-than-you-think/

- Dashboards for monitoring and analysis and AI applications: machine learning and other techniques

OREGON MANUFACTURING INNOVATION CENTER (OMIC)[66]

The term *artificial intelligence* is often used to describe a distinct subset of computer-based processes. To the layperson, AI is the effort to give computers and data processing robots human-like judgement and analytical abilities.

Although that is possible, and some would argue inevitable, the primary role of AI today is using the rapid processing ability of computers to run calculations against set parameters. AI has advanced to the point where it is no longer necessary for humans to do the repetitive, tedious, and time-consuming calculations necessary to conduct critical tasks such as review analysis and optimization of product design and prototyping, as well as development and optimization of manufacturing processes (e.g., cutting tool paths). As long as the parameters and factors for evaluation are known, such as measurement tolerances and what forces the design needs to withstand, AI can make decisions within those parameters and give a far more focused range of viable options to the end user in a very short period of time.

This is, of course, just one example, but a potent one. The challenge facing industry is that few are aware of this capability, fewer understand its importance, and even fewer are willing to trust calculations made in a black box when they have a dozen engineers already on staff that can do that work.

As a final note, it might be argued that such use of computing capability will eliminate the need for engineers. It could be argued instead that it eliminates the tedious tasks engineers face and empowers them with the time to develop new technologies and approaches rather than running endless calculations. It is a powerful tool to force multiply the innovative capability that is still uniquely human.

PROFESSIONAL BUSINESS SERVICES[67]

AI used in professional business services leverages the opportunity for optimization in nearly every facet of the business. As such, it is necessary for businesses that are lagging in AI implementation to begin with the most effective strategies. Communication is a vital service in this industry and may be the best avenue to see AI make a big impact. This notion is especially true in light of the global tailspin the workforce has been forced into during the pandemic. For example, Bank of America's chatbot, Erica, can assist banking customers by offering expedited responses to the most frequently asked questions for customer accounts.[68] Putting the business impact into perspective, Bank of America served over 100 million customers with their automated assistant by the start of 2020.[69] AI bots like Erica allow human agents to take on a larger volume of the more complicated questions, and provide

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[66] Oregon Manufacturing Innovation Center (OMIC) | June, 2020.
[67] Hawes Group, Inc. | June, 2020 (unless otherwise noted).
[68] WBR Insights. (nd). "One Million People Are Now Using Erica – BofA's AI-Powered Chatbot." Worldwide Business Research. https://netfinance.wbresearch.com/bank-of-america-ai-powered-chatbot-strategy-ty-u
[69] Business Wire. (December 11, 2019). "Bank of America's Erica® Surpasses 10 Million Users, Introduces New Capabilities." San Francisco, CA. https://www.businesswire.com/news/home/20191211005345/en/Bank-of-America%E2%80%99s-Erica%C2%AE-Surpasses-10-Million-Users-Introduces-New-Capabilities

consumers with a faster way to engage with services in banking and finance. Technology that responds with real-time customer data will be a vital addition to the professional services' ecosystem of AI tools.

TECHNOLOGY[70]

AI technology is composed of many different kinds of technology, each of which requires different skill sets, education, and professional experience. Some of these component technologies include computing power, machine learning (e.g., data analysis, text and language-based synthesis, and logic that enables computers to recognize patterns), and user-experience interfaces. Each of these technology components requires software and hardware engineers, user-experience and user-interface designers, cloud computing architects, data analysts, data scientists, and data engineers.

The adoption of AI technology will happen fastest in occupations where there is a significant amount of repetitive, well-defined tasks, little complexity or nuance, and *very infrequent change*. Examples of such occupations include computer support specialists, receptionists, market research analysts, and advertising salespeople.

As experienced during the COVID-19 pandemic, AI breaks down when the inputs are dynamic and variables are constantly changing. This struggle occurs because AI technology is only as useful as the data that is used to train the AI. Consequently, in the near term we are seeing the following workforce trends related to AI:

- Apart from the very largest tech companies (Apple, Amazon, Facebook, Google, and Microsoft), many companies furloughed or laid off data scientists in the past couple of months. Uber completely closed down its AI research lab, and Airbnb also laid off a large number of data scientists.
- For the vast majority of tech and tech-enabled companies, "data engineers"—software engineers who can collect data, "scrub" it, and upload it to a cloud-based AI service such as those offered by the very largest tech companies—are in high-demand. Companies point to data engineers as the next phase in the evolution of AI. Over the long term, companies remain bullish on the prospects of AI technology to transform entire industries.
- As AI technology continues to evolve and become more sophisticated, tech companies will need more people to fill strategic, high-touch, and empathetic positions such as customer success specialists, product roles, ethicists, writers/editors, managers (e.g., HR, PR, marketing, and sales), anthropologists, and psychologists in addition to the technical roles needed to develop technologies that interact with cloud-based AI services.
- The COVID-19 pandemic has affected millions of jobs and accelerated the trend toward increased digitization of work. As economies recover, many individuals will need new skills to return to work or to pursue new jobs and opportunities.
- As organizations of all sizes consider how best to work in this new, largely virtual environment, we'll see increasing adoption of digital technology and, therefore, a stronger demand for digital skills. This includes not just technical jobs, but also the increasing number of jobs that are becoming "tech-enabled." Across almost every industry—including retail, manufacturing, education, and healthcare—organizations are looking to use increasingly automated digital technology in new ways so they can continue to serve their customers and deliver services as

[70] Technology Association of Oregon (TAO) | June, 2020 (unless otherwise noted).

efficiently as possible. Many experts refer to this as "augmented intelligence" to capture the interplay between humans and increasingly intelligent computers. Roughly half of all tech jobs in Oregon are at non-tech companies, and as more and more occupations require digital skills, there will be a tremendous growth opportunity in these roles at both tech and tech-enabled businesses in the state.

TRANSPORTATION[71]

As noted in its final report to the Oregon State Legislature in 2019, the Autonomous Vehicles (AV) Task Force explored potential workforce changes resulting from the adoption and implementation of AV. Current, long-term projections estimate employment changes through 2027, which falls before the window of mainstream AV adoption identified in academic studies. Between 2017 and 2027, Oregon will add 246,000 jobs, a growth rate of 12 percent. Primary driving occupations are also projected to grow by 12 percent, adding 6,500 new jobs over the decade. The fastest growth among this set of occupations is expected for light truck drivers and taxi drivers and chauffeurs (17% each). These projections include self-employment. Secondary AV-affected occupations will add 2,900 jobs (8%). Couriers and messengers' employment will grow 14 percent by 2027, the fastest among this set of occupations. Meanwhile, two others – postal service mail carriers, and motor vehicle electronic equipment installers and repairers – will see employment declines by 2027.

Across all occupations in Oregon, for every one new job created, there will also be roughly nine job openings requiring newly trained workers to replace those who leave the labor force (largely due to retirement) or make major occupational changes. Among primary driving occupations, that ratio will be 10-to-1, and among secondary affected occupations, projections show 15 replacement openings for every one new job by 2027. Overall, primary driving and secondary AV-affected occupations will account for 117,500 of Oregon's 2.6 million total job openings.

A 2018 report prepared by Groshen, Helper, MacDuffe, and Carson for Securing America's Future Energy (SAFE) outlines a framework for determining the shares of jobs in primary driving and secondary AV-affected occupations under four different AV adoption scenarios.[72] The report assumes household and commercial AV adoption occur separately from one another, on slightly different timeframes. The report identifies two household AV adoption scenarios.

In one scenario, most households own their autonomous vehicle ("Cars Personal"). The other household scenario involves the use of AVs through a shared fleet of vehicles owned by a company ("Cars Fleet"). Both scenarios assume household AV adoption begins around 2020, and rapid adoption starts near 2030. The SAFE report also identifies two commercial AV adoption scenarios. Under "Trucking slow" adoption, Level 1/2 automation becomes mainstream in the 2020s, Level 3/4 automation goes mainstream in the 2030s, and advanced Level 4/5 starts becoming available in the 2040s. Their "Trucking Fast" scenario uses the same progression, and assumes roughly 10 years faster timeline, with Level 4/5 full automation nearly complete in the 2040s.

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[71] State of Oregon. (September 12, 2019). *Task Force on Autonomous Vehicles: 2019 Final Report to the Oregon State Legislature House Bill 4063 Task Force.* Salem, OR. https://www.oregon.gov/odot/Get-Involved/Documents/AV%20Task%20Force%20Report%202019%20FINAL.pdf

[72] Groshen, Helper, MacDuffe, and Carson. (June 2018). "Preparing U.S. Workers and Employers for an Autonomous Vehicle Future." Prepared for Securing America's Future Energy.

Under each of these scenarios, the SAFE report estimates the share of jobs affected in primary driving and secondary AV-affected occupations. The 2027 employment estimates for primary driving and secondary AV-affected occupations in Oregon combined with the SAFE shares of affected jobs in those occupations create a foundation for additional analysis. Using these numbers, we can make rough estimates of the number of Oregon jobs affected by the 2040s under each combination of household and commercial AV adoption scenarios.

Oregon's primary driving occupations and secondary AV-affected occupations will still account for 5 percent of total employment with 104,000 jobs in 2027. Over the following 10 to 15 years, the household AV adoption scenarios could affect between 11,700 and 14,700 jobs. That totals between 11 percent and 14 percent of all jobs in those occupations. Commercial trucking scenarios could affect between 29,800 and 32,600 jobs in these occupations looking into the 2040s. Those impacts would be felt for between 29 and 31 percent of all jobs in primary driving and secondary affected occupations.

Taken together, the various combinations of personal and commercial AV adoption scenarios could affect between 41,500 and 47,200 jobs in Oregon, starting around the year 2030. The largest impacts would occur for heavy and tractor-trailer truck drivers under the commercial scenarios, where 16,200 to 17,500 jobs could be affected. Under the household AV adoption scenarios, estimated job effects are largest for automotive service technicians and mechanics (4,000) and service station attendants (2,600 to 3,900).

Workers in primary driving jobs affected by AV adoption are slightly more likely to be workers nearing retirement. While one out of every four jobs in Oregon is held by a worker age 55 or older, about one-third of workers in primary driving jobs are at least 55 years old. The mainstream adoption of autonomous vehicles will also create new jobs and entirely new occupations in transportation, in supplier and support activities related to AVs, and in other areas of the economy. Future research efforts can more fully capture workforce effects by including an analysis of new and emerging occupations related to autonomous vehicles.

In addition, we currently only have the capacity to discuss net employment changes beyond 2027. Yet net employment growth accounts for approximately one-tenth of total job openings. We expect autonomous vehicles to disrupt the pattern of replacement job openings, which account for the bulk of total openings. We currently lack a framework to quantify that change.

FEDERAL GOVERNMENT[73]

Artificial intelligence, as noted in a 2019 article from The Organisation for Economic Co-operation and Development (OECD), raises new challenges and is also fueling anxieties and ethical concerns. This puts the onus on governments to ensure that AI systems are designed in a way that respects our values and laws, so people can trust that their safety and privacy will be paramount.

The OECD AI Principles have the backing of the European Commission, whose high-level expert group has produced Ethics Guidelines for Trustworthy AI and will be part of the discussion at the forthcoming

[73] Organisation for Economic Co-Operation and Development (OECD). (May 22, 2019). "OECD AI Principles." https://www.oecd.org/going-digital/ai/principles/

G20 Leaders' Summit in Japan. The OECD's digital policy experts will build on the Principles in the months ahead to produce practical guidance for implementing them.

While not legally binding, existing OECD Principles in other policy areas have proven highly influential in setting international standards and helping governments to design national legislation. For example, the OECD Privacy Guidelines,[74] which set limits to the collection and use of personal data, underlie many privacy laws and frameworks in the United States, Europe, and Asia. The G20-endorsed OECD Principles of Corporate Governance[75] have become an international benchmark for policy makers, investors, companies, and other stakeholders working on institutional and regulatory frameworks for corporate governance. The US government is very much engaged with this work.

The OECD AI Principles

1. "AI should benefit people and the planet by driving inclusive growth, sustainable development and well-being.
2. AI systems should be designed in a way that respects the rule of law, human rights, democratic values and diversity, and they should include appropriate safeguards–for example, enabling human intervention where necessary–to ensure a fair and just society.
3. There should be transparency and responsible disclosure around AI systems to ensure that people understand when they are engaging with them and can challenge outcomes.
4. AI systems must function in a robust, secure and safe way throughout their lifetimes, and potential risks should be continually assessed and managed.
5. Organisations and individuals developing, deploying or operating AI systems should be held accountable for their proper functioning in line with the above principles."

The OECD recommends that governments:

- "Facilitate public and private investment in research & development to spur innovation in trustworthy AI.
- Foster accessible AI ecosystems with digital infrastructure and technologies, and mechanisms to share data and knowledge.
- Create a policy environment that will open the way to deployment of trustworthy AI systems.
- Equip people with the skills for AI and support workers to ensure a fair transition.
- Co-operate across borders and sectors to share information, develop standards, and work towards responsible stewardship of AI."

In a 2018 report entitled "The Work Ahead - Machines, Skills and US Leadership in the Twenty-First Century," task force members outlined seven key recommendations:

[74] Organisation for Economic Co-Operation and Development (OECD). "OECD Privacy Guidelines." http://www.oecd.org/digital/ieconomy/privacy-guidelines.htm
[75] Organisation for Economic Co-Operation and Development (OECD). "G20/OECD Principles of Corporate Governance." http://www.oecd.org/corporate/principles-corporate-governance/

- "Governments should adopt an explicit goal of creating better jobs and career paths for Americans. Initiatives should aim especially at attracting investment and revitalizing entrepreneurship.
- The United States needs to remain a world leader in technology and innovation. This should be supported by increased public and private research and development (R&D), support for commercialization of new research, and an open door to highly skilled immigrants.
- Governments should implement policies aimed at maintaining strong growth and demand for labor. Employers should commit themselves to a 'high-road workplace' that offers employees decent pay, training, scheduling, and benefits. Special measures are needed for communities struggling to attract investment and jobs.
- The United States should set and meet a goal of bringing postsecondary education within the reach of all Americans and linking education more closely to employment outcomes.
- Unemployment insurance should be overhauled to reflect the realities of the current economy, and mid-career retraining programs should adopt the best features of the European 'flexicurity' models.
- Governments and employers should work to reduce barriers to labor mobility for Americans, including high housing costs, occupational licensing restrictions, and inflexible hiring practices.
- The United States should create portable systems of employment benefits tied to individual employees rather than to jobs themselves. Employers should also help fill the gap by expanding benefits for their part-time and contingent workers.
- The president and the nation's governors create a national commission on the U.S. workforce to carry out research, share best practices, and conduct public outreach on workforce challenges. This should be the start of an urgent effort to put workforce issues at the center of the national agenda."[76]

And, as noted earlier, the "National AI R&D Strategic Plan: 2019 Update" identifies the critical areas of AI research and development that require federal investments.[77] The update reflects a continued commitment to the strategic priorities identified in the first plan (2016) and identifies a new eighth strategy focused on public-private partnerships to generate technological breakthroughs in AI and to rapidly transition those breakthroughs into capabilities.

STATE GOVERNMENT[78]

Many, if not all, of the previously mentioned OECD recommendations are applicable to the state government, as is the National AI R&D Strategic Plan. Oregon's Data Strategy "is designed to have some timeless components, such as the principles and practices, in addition to an action plan that will be updated regularly as the state makes progress towards its goals."[79] If not already in play, considering the integration of certain components of the OECD AI principles and components of the National AI Strategic Plan into Oregon's Data Strategy (and/or strategic planning) may be warranted.

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[76] Alden, Edward, and Laura Taylor-Kate. (2018). *The Work Ahead: Machines, Skills, and U.S. Leadership in the Twenty-First Century, Updated April 2018*. Council on Foreign Relations. Washington, DC. https://www.cfr.org/report/the-work-ahead/report/

[77] The White House. (2020). *Artificial Intelligence for the American People*. Washington, DC. https://www.whitehouse.gov/ai/

[78] Darmon, Eyal. (August 26, 2019). Channeling AI into Government Citizen Engagement (Contributed). *Government Technology*. https://www.govtech.com/opinion/Channeling-AI-into-Government-Citizen-Engagement-Contributed.html

[79] Oregon's Data Strategy. https://www.oregon.gov/das/OSCIO/Pages/DataStrategy.aspx

And, before leaping to adopt new technologies, government agencies must think holistically about the improvements and changes they will need to make to achieve the full potential of AI that results in a better customer experience. A chatbot interface that delivers poor user experiences and unsatisfactory service benefits neither the government nor citizens.

To capitalize on AI's potential, government agencies should consider more than the technological capabilities of the solution they want to deploy. They must ensure that technology enhancements go hand-in-hand with developing people's skills and creating new organizational processes to support AI-powered services to improve the overall citizen experience and reap the rewards of operational efficiency.

Complicated Customer Experience

The public expects fast, accurate service when interacting with the government online, and agencies have deployed many channels and technologies to meet these demands. However, people are often frustrated by complex processes and extended waiting times, and the problem is compounded when services or solutions—chatbots, mobile apps, or websites—are not designed around their needs.

The Oregon State Treasury's OregonSaves program is one example of a government agency putting citizen service needs first. The agency has developed a virtual agent and devised an intent library of questions that are best suited to be answered by a virtual agent or chatbot. The result: High-quality customer service and more than 10,000 customer messages answered by the virtual agent to date.

Government call center operations are ripe for transformation by AI in the near future. Voice recognition and language processing will enable intuitive digital experiences that surpass traditional interactions, improving customer satisfaction, and reducing cost. AI platform skills and data-driven applied intelligence technologies will enable game-changing organizational insights for leaders.

Fortunately, government agencies have access to a new generation of AI-enabled chatbots, capable of detecting caller intent and responding to the root causes of customer inquiries, considerably reducing call volumes.

Recently, a government call center sought to automate routine inquiries to deliver faster customer service while lowering costs. It developed an integrated approach, combining more contextual search for a public website, a digital assistant for web chat and phone interactions, and an email handling agent. In taking these steps, the agency made personalized service available outside of standard operating hours. The result was a 30 percent improvement in service speed, with 60 percent of customer interactions handled without human intervention.

ECONOMIC DEVELOPMENT[80]

Growing Oregon's traded sector industries is at the heart of the State of Oregon's economic development strategy. Home to the Silicon Forest, the state's concentration of high technology companies has made a name for Oregon across the globe. Companies like Intel, Tektronix, Mentor Graphics, NVIDIA, Synopsys, and Amazon Web Services have long roots in the region and have spun off

[80] Business Oregon | 2020 (unless otherwise noted).

hundreds of other startups. Today there are 4,184 high-tech firms statewide. Oregon's robust high-tech ecosystem provides a competitive advantage for any growing technology company.

AI is included under the Software and IT Target Industry Group of the economic development strategy and is one of the fastest growing industry groups in Oregon, with more than 50 percent employment growth over the past 10 years. Nearly 3,700 Software and IT establishments call Oregon "home." Software and IT companies are growing in Oregon due to the attractiveness of the state to younger workers and the lower cost of doing business here compared to other west coast software and IT hubs.

In a testament to the attractiveness of the industry, three months into the COVID-19 pandemic, there were over 500 open recruitments for AI talent in the Portland metro area. AI companies will continue to be a priority for the state to support local business expansions and incentivize out-of-state recruitments and foreign direct investment to Oregon in partnership with local communities, higher education, and workforce partners. It is through these partnerships and efforts that more formal education and training programs are developed.

EDUCATION AND TRAINING[81]

The economic impact of the COVID-19 pandemic has been described previously in this report. However, this economic disaster does have a silver lining. Historically, any economic downturn or increase in unemployment will push more people back to school and training programs to learn new skills. To protect Oregon's future economic success, increasing education in the field of AI is of vital importance.

Unfortunately, AI programs are currently overfull and understaffed due to the huge and recent surge in interest. To provide a concrete example, here are the desired specializations listed on computer science (CS) graduate applications at Oregon State University (OSU) over the last five years:

Table 2. Desired specializations listed on computer science graduate applications at OSU

	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
AI	203	318	468	540	569
Other CS	298	290	191	184	144

Applicants who want to study AI have almost tripled, whereas those students interested in other aspects of computer science have decreased by half. To address this issue, OSU has begun the process of creating a graduate program specifically for AI.

The expansion of AI programs at the graduate level is of enormous importance, but it cannot fully address the talent shortage. Current estimates are that demand for AI positions are an order of magnitude higher than the supply of graduates, and that this gap will only continue to grow. In order to meaningfully address this shortfall, conferring more advanced degrees cannot be the only approach– there are simply not enough people with the interest, motivation, and talent to earn a graduate degree. There are many other approaches that educational institutions can take.

While a couple of universities, such as Carnegie Mellon, have an entire AI department, and a few others

[81] From Education Sub-Committee of WTDB AI Task Force | 2019-2020 (unless otherwise noted).

such as Stanford, University of North Carolina (UNC), and OSU offer AI-specific undergraduate degrees within a broader CS major, this is the exception rather than the rule. At most colleges and universities, undergraduate education in AI and machine learning is limited to a handful of 400-level elective courses that are only open to CS majors. The reasons for this are twofold. First, AI had been an esoteric and specialized field for decades and the tiny demand for courses in years past made it a good fit for a graduate-level program. Clearly, this situation no longer exists, and programs will grow according to increased demand. The second reason is far more problematic–AI is difficult and requires extensive background in both mathematics and computer programming.

Making courses in AI accessible to undergraduates will be challenging for the people designing programs and curricula and even more challenging for the professors teaching them. However, this is a challenge that can and must be overcome, for both future professionals in both AI developer and AI user career trajectories.

Another imperative yet challenge for educators designing curricula and programs is to emphasize the need for human skills development including emotional intelligence, creativity, empathy, and other essential employability skills. And, integrating this component into the program while determining how to best measure proficiency in these skills accurately is the key to maximizing the realized benefit to employees and employers. The importance of the development of these skills is uncontested and there should be better aligned efforts and improved systemic requirements as part of the K-12 experience for students in Oregon. With it, students would be better prepared to succeed in an AI program in postsecondary education.

Community colleges and universities are moving forward on identifying and assessing the achievement of learning outcomes that should support the development of critical thinking, communication, and other essential employability skills needed in the AI-influenced economy of the Fourth industrial Revolution.

The undergraduate degree program for an AI developer track within a specific CS department was designed by a team of educators, administrators, and industry leaders from many institutions across Oregon including Portland State University (PSU), OSU, University of Oregon (U of O), Portland Community College (PCC), Oregon Institute of Technology (OIT), and Portland Public Schools (PPS). Since there were a few participants from Portland State University, their CS program provided a starting point. The proposed two-year program includes recommended courses in Computer Information Systems, Math and General Education.[82]

The changes to the existing CS program would be significant, including many more required mathematics courses, four new AI courses, numerous additional AI electives, and an AI capstone project in the final year. With this proposal, an undergrad would take the prerequisite mathematics and computer programming courses, six dedicated AI courses, and complete a year-long AI project. This would put their educational experience in AI on par with many master's programs. If Portland State University actually decided to create such a program, it would probably turn out a bit differently than the one pictured here. However, it seems straightforward to create an undergraduate AI degree at any

[82] Two-Year AI Degree Plan.
https://docs.google.com/spreadsheets/d/1losNb1jcCzYjxUpBvAsol3zRVoNNJGhWxMvSTwDwJJI/edit#gid=0

college or university by leveraging existing math and CS courses, creating some new AI courses, and hiring the new faculty to teach them.

Community colleges must also play a dynamic role in AI education. Currently, undergraduate CS students can take two years of lower-division courses at a community college, then transfer to a university to complete their degree. The process of creating an AI transfer program would be similar to the four-year AI program, just at a smaller scale. It would require introducing a couple of new lower-division classes that could probably be taught by existing faculty. A recommended transfer map for AI builds could build from an existing computer science transfer map at Portland Community College.[83]

Community colleges have another important role to play in AI education: associate degrees and certificates. For a two-year degree, students would not learn the advanced mathematics or programming skills needed to design AI systems from scratch but would instead learn the more basic skills required to use AI systems that already exist. This strategy would include development of a new postsecondary career and technical education (CTE) certificate and degree programs to increase equitable access to the AI sector.

An analogy may be useful here. Automobiles are an essential technology that is well-integrated into our society. Therefore, there are many ways in which people engage with the technology. Some people receive advanced degrees in mechanical engineering and design combustion engines, others receive two-year degrees and become auto mechanics, still others work in the factories that build the cars. As the AI industry matures and stabilizes, the need for many supporting roles will develop in the field. For example, an AI associate degree could be given to a student that has mastered statistics, basic data analysis, some computer programming in Python, and a commonly used AI platform such as Tensorflow. Such a person could be an "AI mechanic." As another example, a certificate could be given for data preparation or data mining that would involve basic work in Excel or SQL. Programs like these would make excellent opportunities for retraining low-skilled workers that may have been displaced by either AI or the COVID-19 pandemic.

There are many other strategies for increasing AI education besides creating an AI department, degree track, or certificate. Postsecondary educational institutions could relax prerequisites on existing AI courses, increase offerings of upper-division AI electives, modify curricula to include more AI examples within existing CS courses, introduce new lower-division introductory AI courses, or even create non-technical exploratory AI courses for non-CS majors.

P-12 schools could offer similar exploratory courses to generate even more interest in AI, or simply to educate future citizens about AI's usefulness, power, and societal implications.

Sunset High School has a great example of an AI Saturday Academy course. This class is a survey of AI through a variety of experiences. It involves looking at board games, decision trees, Bayesian networks, genetic algorithms, evolutionary art, state machines, neural networks, and robotics. During the process, students will attempt to write code for their own AI bot using the software, Robocode.

In another course from Sunset High, computer literacy and programming are explored more generally. In Explore Computer Science and Engineering students learn the fundamentals of programming and

[83] Two-Year AI Degree Transfer Map.
https://docs.google.com/spreadsheets/d/1kgoURJlkLfFFZlmWNVgT4vIuEjorzW6jCi_s578tIOY/edit#gid=0

engineering design. They explore these principles through learning web design, robotics, 3D modeling, circuitry, app design, invention prototyping, and more. They are also introduced to computer hardware and networking, digital security and privacy, and intellectual property. There is an emphasis placed on communication, collaboration, and supporting one another in skill development. This course uses hands-on learning and student-centered projects to help nurture students' curiosity and build their confidence with technology.

Courses like the ones above could be offered to more students and in more schools. The addition of a basic computer literacy course as a graduation requirement could include a module on AI.

These proposals are considered in more detail below in the Policy Recommendations section.

POSTSECONDARY OUTCOME-BASED FUNDING MODEL[84]

Initiatives like those described in the previous section will be necessary to create a foundation of AI education in Oregon, but, like any new programs, they will need funding. To give a sense of scale, OSU's proposal for the AI graduate program mentioned above estimated that between five and eight new full-time faculty and staff would be needed, at a cost of millions of dollars per year. Luckily, in Oregon, a tried and true funding model successfully distributed hundreds of millions of dollars for engineering education initiatives over two decades: the Engineering Technology Industry Council (ETIC).

In 1997, passage of Senate Bill 504 created the ETIC to oversee state investment in the engineering and computer-science cluster, with a focus on the Portland-Metro area. This new initiative was housed under the Chancellor's Office and prioritized investments to:

- Build faculty capacity in high-technology areas.
- Enhance program capacity in collaboration with the Oregon Graduate Institute of Science and Technology (OGI).
- Strengthen skilled technician training.
- Expand engineering programs offered.

The results achieved by the ETIC were significant. The number of engineering graduates tripled and research expenditures more than tripled in engineering and technology. Programs at OSU College of Engineering, PSU College of Engineering, and Oregon Institute of Technology's College of Engineering, Technology and Management were substantially strengthened. Faculty and student diversity and gender balance increased. The work resulted in 70 key faculty hires and supported grants, graduate work, start-up packages, and lab buildouts.

ETIC funding transitioned from actively managed grants and supports for particular programs to ongoing support for faculty and educational/R&D capacity. During the transition from the Oregon University System to independent universities and the founding of the Higher Education Coordinating Commission (HECC), the ETIC Council determined it was best to restructure its funding approach in

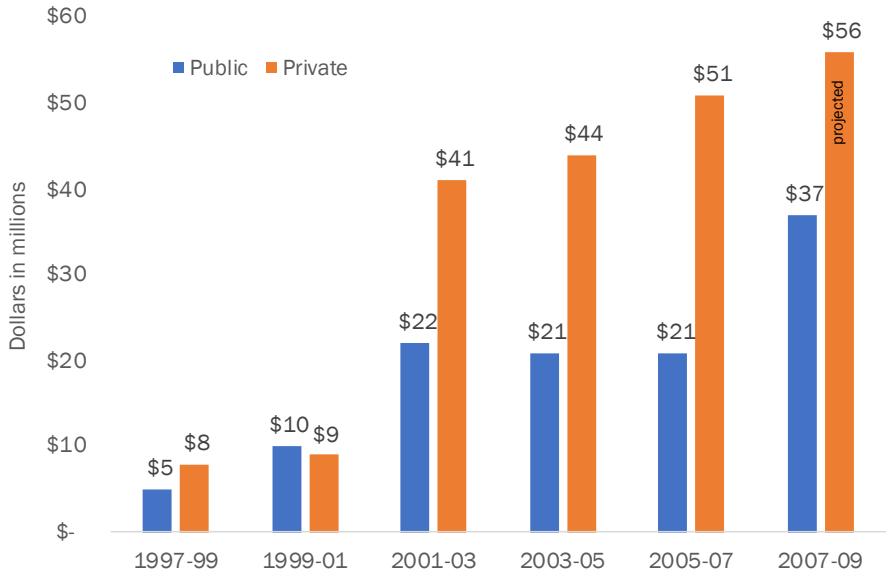
[84] From Education Sub-Committee of WTDB AI Task Force in conjunction with Oregon Business Council and Oregon Institute of Technology | 2019-2020 (unless otherwise noted).

2013.

Restructured under the HECC, the Council's funding was transitioned upon its recommendation to a "Renewable Fund" and "Sustaining Fund." The Renewable Fund would allow for grant-based activity and scaling up of new initiatives and encompass roughly one-quarter to one-third of the overall funding pool. The Sustaining Fund would support the infrastructure that had developed across the seven universities but would be allocated based on ongoing performance–not existing costs.

Data show that from 1997 to 2009, many gains were made through the ETIC partnership in developing a strong engineering and technology workforce: engineering graduates increased 30 percent to 1,500 per year, federally funded research increased 88 percent to $56 million per year, and more than $100 million in private support was given to university programs.

Figure 8. Private support of ETIC magnified state investment



Source: Engineering and Technology Industry Council. (2008). *Building Oregon's Economy through Investing in Education and Research.*

The strength and success of ETIC was due to its simple structure. Executives from companies standing to benefit from increased engineering education formed a voting board that evaluated proposals from educational institutions. Proposals that were funded received matching funds from those companies, often in the form of donated staff and equipment. In 2017, ETIC was folded into the Oregon Talent Council, which was then repealed and integrated into the Workforce and Talent Development Board.

During 2017 and 2018, a cross-university group was convened by the HECC to establish the ETSF funding methodology. The new formula drives the allocation of an approximately $27-million biennial allocation and includes:

- Limited base funding for all universities to support some STEM-based curricula
- Outcomes funding directly linked to degrees, research and development, and employment of graduates in Oregon

Proposed outcome-based model for Oregon residents

- Allocates funds based on the number of community college, undergraduate, and graduate degrees awarded in targeted areas with priority on closing attainment gaps for women, people of color, and low-income and rural communities.
- Research and development
    - Funds based on doctoral degree production in targeted areas (60%) and proportion of total R&D in targeted areas (40%).
- Wages and employment in Oregon
    - Tracks graduates in targeted areas who remain in Oregon and work in the state of Oregon based on a wage-adjusted basis (i.e., the higher the wages of graduates, the more funding for a community college or university) based on Oregon Employment Department data.
- Targeted programs are computer science, engineering, mathematics, and computer science, engineering technology, and potentially others.

Our proposal is for the WTDB to reboot the ETIC model with similar structure and goals, but to focus on AI talent development rather than engineering. To create this "council," the WTDB would recruit top-level executives from leading AI companies to form a sub-committee of the WTDB whose goal would be to evaluate proposals and distribute funds to AI educational initiatives, while those companies represented on the committee would match funds.

In this true public-private partnership structure, there would be a requirement that any proposal submitted must address the lack of diversity in the AI field. In order to be funded, a proposal would need to demonstrate how underrepresented populations would be included in the new program or strategy. Consideration for use of registered apprenticeship, work-based learning, and other innovative approaches would also be a component of the committee's work.

POLICY RECOMMENDATIONS

The WTDB AI Task Force makes the following recommendations to Oregon's Governor and legislature.

SOCIETAL AND ETHICAL

- Adopt the OECD AI Principles[85] that focus on how governments and other actors can shape a human-centric approach to trustworthy AI.
- Develop public-private partnerships to integrate educators, AI practitioners, and Oregonians interested in the societal and ethical concerns of AI.

[85] Organisation for Economic Co-Operation and Development. (2020). "OECD Principles on AI." https://www.oecd.org/going-digital/ai/principles/

- Work with Oregon businesses to incorporate AI into the WorkSource Oregon (WSO) labor exchange system in order to de-bias the system to advance diversity and inclusion and avoid discrimination in this system.

EQUITY

- Adopt common outcomes and measures across funding streams regarding education and training using disaggregated data to identify and help close equity gaps and regularly report to the community. Increase data sharing where necessary to accomplish this recommendation.
- Work with HECC to develop strategies for improving access to and completion of postsecondary educational pathways for adults to support the new Adult Education and Training Goal with retraining workers displaced by AI and preparing low-skilled adults for entry into AI-related or affected fields.
- Work with Business Oregon's Broadband Office established by Executive Order to provide good broadband connectivity and access across Oregon. This is essential for AI to perform optimally, to close the digital divide, and for AI's benefits to be distributed equally.
- Support Oregonians in a 21st century economy by recognizing the importance of the social determinants of health, trauma-informed care, and holistic program delivery. Workforce development is beyond skill and talent development; it is also about affordable and accessible childcare, housing, transportation, food security, and other support services.

EDUCATION AND TRAINING

- Work with the Oregon Education Department and the Oregon STEM Council to increase appropriate introductory AI, computer science and programming, and applied mathematics curricula for all Oregon P-12 students.
- Work with HECC to create equitable AI programs to bring faculty members across Oregon's community colleges, public colleges, and universities together to create standards, curriculum, certifications, and solutions that are cognizant of bias, ethical, legal, and moral issues.
- The above P-12 and postsecondary education and training work should have a two-pronged approach to build AI developers and, more importantly, AI users.
- Support the work of the WTDB's Essential Employability Skills Task Force to develop statewide and aligned essential employability skills in areas like social-emotional growth, critical thinking, initiative, teamwork, project management, and entrepreneurialism, which are critical to all work including AI-connected work.
- Review the state requirements and explore opportunities for smaller operations to implement successful apprenticeship programs and to increase the "pool" of carded electricians related to robotics and automated, AI-related manufacturing.
- Develop public-private centers-of-excellence to position Oregon as a leader in AI education, research, development, and/or application.

OUTCOMES-BASED FUNDING

- Establish the AI Talent Investment Committee of the WTDB with required private-sector

membership and a public-private investment and match model.
- Establish and fund an outcomes-based model to directly link to AI degree/certificate completion, AI career pathway research and development, and employment with Oregon employers
- Outcomes-based funding model must prioritize closing attainment gaps for women, people of color, and low-income and rural communities potentially using equity weights.

INCENTIVES

- Provide incentives for private investment in software, sensing technology, training, and other applications to encourage investments in this type of AI-related technology, resulting in better economic efficiency and energy conservation.
- Provide incentives for businesses to encourage new and/or expanded apprenticeship programs and increase the number of apprentices in Oregon.
- Provide incentives for current and new businesses to actively engage with local P-12 and secondary schools to increase career-connected learning, especially related to STEAM.

STATE GOVERNMENT

- Explore opportunities with AI for data analytics within state agencies to identify inefficiencies and data-integration needs across departmental systems, perhaps through creation of a State Innovation Office.
- Work more closely with the WTDB, OBC, and other public and private entities to better align education and training in AI and other fields based on the needs of employers and economic data.
- Promote AI solutions that focus on the impact of climate change and electricity systems, transportation, buildings and construction, food and agriculture, forests, education, and policy evaluation.

CONCLUSION

The Fourth Industrial Revolution brings with it many social, political, cultural, and economic issues, as well as opportunities. This revolution will be driven largely by the convergence of digital, biological, and physical innovations. AI will be at the center of this convergence.

AI will continue to present unprecedented challenges globally and in Oregon. Many Oregonians will likely benefit in this rapidly evolving, AI-based economy. Others will struggle without a forward-thinking strategy that includes proactive leadership and effective state policy. We must step up, plan, and deliver on what is needed to help equip Oregonians with the skills, knowledge, and abilities they will need to succeed in our future economy. The business community, public sector, and other talent-development-system partners must work together more collaboratively than we ever have before. We must align our efforts, be flexible and nimble, and strive for a future with equitable prosperity throughout all of Oregon's communities. We must take action now.