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Transforming Blue-Collar Work into White Collar Jobs: Lessons and Technological Opportunities from Japan's Extreme Demographics for Inland California

Kenji Kushida

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Kenji Kushida
Senior Fellow, Carnegie Endowment for International Peace
Kenji.kushida@ceip.org

Introduction

California's inland regions sit at the center of the state's food, water, logistics, energy, and land-use systems. Yet they lag behind coastal cities in wages, innovation intensity, and access to high-skill jobs. Labor shortages are already occurring in various key sectors including agriculture, construction, forestry, healthcare, and transportation. When considering pathways and possible solutions to inland California's challenges, experiences of Japan actually provide a *model for transforming blue collar work into white collar jobs* that has the potential to increase wages, productivity, and regional vitality**,** especially when paired with coordinated government policy, institutional support, and private sector investments.

Japan faces an extreme demographic trajectory of rapid aging, a shrinking labor force, and accelerating rural depopulation. As measures to increase birthrates and decelerate depopulation have been largely unsuccessful, and with the country facing a populist backlash against dramatically increasing foreign workers, Japan has been forced to take serious steps to redesign work, industry, and social systems with the assumption that labor scarcity will be permanent. At its core, Japan's demographic crisis is driving a technological trajectory of transforming blue collar jobs into white collar work.[i]

Across a broad range of sectors such as construction, agriculture, healthcare, and logistics, Japan has deployed automation, robotics, AI, and digital workflows not primarily to replace labor, but to do the work for which there are not enough workers. The upskilling of work, and to retain older workers or others who traditionally are not traditionally a good fit for jobs that have been physically demanding, are particular targets of transformation. [ii]

Japan's experiences are directly applicable to California's inland regions. Acute labor shortages, aging workforces, the need to create real rising wages while improving productivity, and how to create "good" jobs that benefit workers and the region, are all challenges that are fundamentally similar to Japan's demographically-driven challenges. Therefore, many of the solutions undertaking by Japan, in some cases through Japanese firms collaborating with California technology firms, are directly relevant as a set of solutions to a range of challenges facing California.

This chapter analyzes Japan's shift from blue-collar, manual, place-bound work to white-collar, data-driven, supervisory and knowledge-based roles, enabled through private sector efforts,

government–industry coordination and a deliberate policy agenda of labor automation and augmentation.

Automation Versus Augmentation

A critical technological distinction is useful to understand Japan's trajectory of transforming work: the difference between *automation* and *augmentation*. Since the 1960s, two distinct paradigms have emerged in artificial intelligence and robotics development. Automation seeks to replace human capabilities entirely, removing workers from tasks and potentially eliminating jobs. Augmentation, by contrast, focuses on enhancing human capabilities—enabling workers to perform tasks more efficiently, safely, or with skills they did not previously possess.[iii] While augmentation can certainly be a pathway towards automation, at least in the near future augmentation will still play a major role in what is currently considered blue collar or manual work. (Current excitement over "physical AI" may replace manual, physical labor in a wide variety of real world conditions sooner or later, but the challenges remain high.)

In most global discussions, automation often carries negative connotations such as with job displacement and unemployment. Especially with recent advancements in generative AI and layoffs across a wide range of firms in the name of AI, a broadening range of white collar jobs are seen to be as risk around the world. However, in Japan's context of severe labor shortages, automation addresses a different problem: there are simply not enough workers to perform essential physical tasks, ranging from construction to healthcare and transportation. The political and social dynamics are fundamentally different from replacing current workers; rather than automation eliminating more jobs than workers, Japan faces massive and growing numbers of unfilled positions.

As specific technology deployment types, making the distinction between AI (artificial intelligence, focused on replacing humans) and IA (intelligence augmentation, focused on enhancing humans) can be particularly useful for understanding possible technology deployment trajectories. Many physical systems labeled as "AI" in commercial contexts are actually IA systems—tools that amplify human capabilities rather than replace them entirely. For example, an excavator with automated blade control does not eliminate the operator but instead enables a novice to perform tasks that previously required a decade of experience. A truck convoy system with one driven truck and two driverless followers does not eliminate drivers entirely, but essentially triples the productivity of each remaining driver. Remotely operated heavy equipment still requires expertise, but the work can be done by a far more flexibly deployed set of workers, from air-conditioned and controlled office environments.

This augmentation approach is transforming blue-collar work into something fundamentally different—positions requiring less physical strength and experience, but more digital literacy and systems thinking. Workers increasingly interact with interfaces, monitors, and software rather than purely with physical materials. They make decisions based on sensor data and algorithmic recommendations rather than purely on manual feel and experience. This represents not a replacement of blue-collar workers but a redefinition of what blue-collar work entails.

Demographically Driven Technological Trajectories

Technological development and deployment do not follow straight forward paths determined solely by scientific, technological and engineering capabilities. Rather, technological trajectories are usually shaped by economic, political, and social factors specific to particular contexts.[iv] Japan's extreme demographics are creating specific market opportunities, acute labor shortages, and favorable political and regulatory dynamics that are driving technological development along specific trajectories.

Market opportunities of unprecedented scale are being driven by Japan's extreme demographics. With half of all Japanese households containing at least one member over age 65,[v] and with approximately one-seventh of the entire population projected to suffer from dementia by 2030, [vi] the demand for labor-saving technologies and productivity enhancements is enormous. Companies that can address these needs have access to a substantial domestic market before expanding internationally.

Acute labor shortages change the industrial cost-benefit calculations of hiring people versus developing technological solutions. When workers are scarce, wages rise, making automation and augmentation technologies economically viable at earlier stages of development. And when labor shortages become so tight that employers cannot find workers at any price in depopulating areas, this creates demand for technological alternatives.

Favorable political and regulatory dynamics can emerge when technological solutions address broadly recognized social problems. Unlike technologies that primarily displace workers and therefore generate political opposition, government efforts to develop and deploy technological solutions to cope with labor shortages create political tailwinds. Regulatory frameworks can be adjusted more easily when the alternative is a looming collapse of services collapse rather than job displacement.

For California's inland regions, these dynamics offer important lessons. While California's demographics are not as extreme as those of Japan, specific sectors and regions face similar pressures. Agricultural labor shortages, difficulty attracting workers to physically demanding jobs, and an aging workforce in traditional industries create similar imperatives for technological transformation. The question is not whether transformation will occur, but whether it will be managed proactively to benefit workers and communities, or reactively as industries struggle with labor crises.

Case Study 1: Construction—IA and Remote Operations Transform Work

The Challenge: An Industry Losing Its Workforce

Japan's construction industry faces the steepest rise in workforce aging across all major industrial sectors. The proportion of workers above age 55 reached 36 percent in 2022, rising from 25 percent in 2002. Simultaneously, workers below age 29 decreased from 19 percent to just below 12 percent.[vii] This represents not just aging but a failure to attract new workers to an industry traditionally requiring years of apprenticeship to master physically demanding skills.

Construction work traditionally combined extreme physical demands with high skill requirements. Summer months of grueling and increasingly dangerous heat, with freezing and snowbound winters are working environments that repel many potential workers. And operating heavy equipment like excavators and bulldozers require specialized licenses, and beyond that, often years of experience to perform advanced tasks. The "feel" for precise angles when carving hillsides, the judgment to adjust blade pressure on uneven terrain, and the spatial awareness to operate multi-jointed equipment from a seated position without clear sightlines all represent tacit knowledge acquired through years of experience.

This tough physical environment and lengthy skill acquisition process deterred younger workers from entering the industry. At this point, however, construction projects can incur delays not only from lack of equipment or materials but also from the lack of skilled operators. There are also serious safety implications as aging workers attempt physically demanding tasks on construction sites and in buildings.

Technological Solution: Embedding Expertise in Machines

One critical paradigmatic technological solution to Japan's severe labor shortages is embedding expertise into machines. Komatsu, a leading construction equipment manufacturer with global reach, pioneered a solution that fundamentally transformed the skill requirements for operating heavy machinery with by introduced a line of "Information and Communications Technology (ICT) Construction Equipment" from 2013—well before the current AI boom of the 2020s. [viii]

The "ICT bulldozer" pioneered this transformation. Traditionally, creating flat surfaces with a bulldozer required constant manual adjustments to the blade as the weight load and resistance of pushed material changed continuously. Experienced operators developed a feel for these adjustments through years of practice. The ICT bulldozer, however, uses computer-controlled blade adjustment that automatically compensates for these factors. The operator needs only to move the bulldozer forward; the blade adjusts itself, producing surfaces flatter than most experienced professionals can achieve manually.

Similarly, the ICT excavator, introduced in 2014, addresses the high-skill requirement of carving precise angles in hillsides. Previously requiring up to a decade of experience for the most difficult cuts, this task becomes dramatically simplified. The operator positions the bucket at the beginning point and pushes the "semi-auto" mode button. Sensors embedded throughout the equipment monitor position and angle, and the excavator proceeds to dig according to prescribed specifications.

Critically, these systems represent augmentation rather than full automation—a deployment pattern of IA (intelligence augmentation) rather than AI (artificial intelligence). The operator must still position equipment, identify obstacles, and make most decisions and be licensed to operate the machinery. However, the system handles the fine motor control and precision that previously required years to master.

Paradigmatic Solution: Remotely Operated Excavators

Earthbrain, a Tokyo-based joint venture established in 2021 by Komatsu (65%) along with communications giant NTT Docomo (35.5%), Sony Semiconductor Solutions (5%), and Nomura

Research Institute (5%), provides systems that enable excavators to be operated remotely. The "Smart Construction Teleoperation" system developed by Earthbrain began commercial sales to companies around the country in 2023.[ix] The system has cockpits with multiple screens and levers equivalent to those found in an actual excavator are arranged in pod-like arrays that can be far from the actual excavator sites. While communications latency limits the distance, and a deployment 20 kilometers away requires a van located in between the sites to amplify the signal, licensed excavator operators are operating excavators in remote areas from downtown offices. [x]

While depth perception on flat screens still make it difficult for operators to operate in fine movements, firms who deployed these systems report that can are quite useful in mobilizing especially female workforces who tend to have responsibilities such as childcare that are not well suited for traveling to remote areas to operate heavy machinery. In excoriatingly hot summers, work can be done in air conditioned offices. Workers with small children might even work in shifts corresponding with daycare in ways that physical construction sites cannot easily accommodate.

Another critical paradigmatic aspect of the teleoperation excavator systems is that the construction companies that purchased and deployed them were not motivated by a one-to-one comparison of efficiency gains or cost reductions of a conventional excavator with a teleoperated one, but rather the severe shortage of workers that drove them to do something different from other companies. As more companies purchase and deploy these systems, technological improvements and increase their functionality, reduce costs, and gain more attention as a realistic possibility for an array of physically demanding on-site jobs.

As remote operations systems embed increasing amounts of intelligence along the IA trajectory, more and more tasks that currently require human operators on-site can be remotely controlled. While fully automated AI-driven construction machinery is further along the trajectory, this IA deployment solution for immediate and acute labor shortages and skill mismatches represents a paradigmatic case from Japan for California and elsewhere.

Government Support and Industry Transformation

Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) actively supports construction industry technology deployment through its "i-construction" initiative, launched in 2016. The initiative explicitly acknowledges workforce aging and shrinking as primary motivations, calling for sensor deployment, network connectivity, and AI to increase productivity. [xi]

The i-construction consortium, established with government support, includes 1,193 firms, 64 government entities, and 37 expert members as of November 2022. Annual awards recognize exemplary projects, creating incentives for innovation and technology adoption. [xii] This government support reduces risk for early adopters and signals policy commitment to technological transformation.

Construction Partnerships with Silicon Valley: Drones Making 3D Maps and Autonomous Dump Trucks

Partnerships with Silicon Valley have been critical enablers for Japanese construction-related firms to pursue their trajectories of automation and augmentation. The combination of labor shortages facing Japanese firms, their manufacturing prowess, global reach, and the strengths in software of Silicon Valley firms, combined with the relatively low levels of regulation in construction and mining sites created market opportunities for collaboration.

For example, construction equipment firm Komatsu partnered with Silicon Valley drone platform company Skycatch to create three-dimensional (3D) maps of construction sites throughout Japan. The use of drones dramatically reduced the time and labor intensity needed for taking measurements in outdoor construction sites; numerous workers using tripod-mounted measurement devices requiring weeks to take measurements were replaced by a twenty-minute procedure of launching a drone, a tactic that could be performed frequently. Komatsu met Skycatch in late 2014 through the Silicon Valley-based venture capital company it had invested in, and by 2016 the partnership was deployed commercially. By mid-2021, over 26,000 construction sites around the world, including sites in Germany, had used this technology.[xiii]

Partnerships between traditional Japanese construction firms and Silicon Valley technology companies were also mutually beneficiary. Obayashi set up an investment and research lab in Silicon Valley—the Silicon Valley Ventures & Laboratory—in 2017. It invested in venture capital firms specializing in construction technology such as San Francisco-based Brick and Mortar Ventures and Boston-based Building Ventures. Obayashi held a start-up pitch competition and demonstration project called the Obayashi Challenge in 2017. This was a useful mechanism for them to meet startups working on construction-related technologies, although SafeAI was introduced through a venture capitalist into which Obayashi invested. [xiv]

Immediately after establishing its Silicon Valley innovation office, Obayashi partnered with SRI International (originally Stanford Research Institute) to develop autonomous hauling robots for indoor construction sites. Obayashi brought its expertise in making robots to haul construction materials inside buildings as they were being built, while SRI developed the software and sensors to enable the robots to move around and avoid objects, holes in the floor, and workers to allow the robots to make their own way to, and operate, industrial elevators. Obayashi also partnered with SafeAI, a Silicon Valley startup, to develop autonomous dump trucks. These partnerships combine Japanese manufacturing and deployment expertise with Silicon Valley software and AI capabilities and represent a pattern of collaborations that can harness California's expertise while harnessing technological capabilities from elsewhere.[xv]

Lessons for California's Inland Regions

California's construction industry, particularly in inland regions where climate extremes make work more physically demanding, faces similar workforce challenges. Summer heat in the Central Valley creates safety concerns for aging workers and makes construction work less attractive to younger generations. The bioeconomy infrastructure proposed for these regions—facilities for biomass processing, water management systems, distributed renewable energy installations—will require substantial construction activity.

The Japanese experience suggests several policy directions for California. First, workforce training programs could emphasize systems operation and digital interface skills that augment, rather than simply replace manual proficiency and specialized equipment operation. Community colleges in inland regions could partner with equipment manufacturers to provide training on ICT-enabled equipment. Second, construction workforce development initiatives can target demographic groups traditionally excluded from the industry. Augmentation-focused equipment that reduces physical strength requirements and shortens skill acquisition time could attract workforces that are currently relatively incompatible with such front-line work—namely women who face family responsibilities and older workers. Remote operations are a particular type of augmentation that is particularly promising, and can be highlighted and incentivized through procurement. Third, regulatory frameworks should encourage rather than impede ICT-enabled equipment adoption. Just as Japan's government actively promotes "i-construction," California could establish incentive structures for projects utilizing labor-augmenting technologies.

Case Study 2: Agriculture—From Farmhand to Data-Driven Agriculturalist

The Crisis in Japanese Agriculture

Japan's farming population presents perhaps the most extreme demographic challenge of any sector. The farming population decreased from 2.05 million in 2010 to 1.23 million in 2022—a 40 percent decline in twelve years. The average age of full time, non-corporate farmers reached 68.4 years in 2022. Most dramatically, 70 percent of farmers were above age 65 in 2022, compared to 61 percent in 2010. Farmers above age 75 comprised 33 percent of the total in 2022.[xvi]

These numbers represent not just statistical aging but an impending collapse. Workers in their seventies cannot physically perform many farming tasks much longer. The rapid decline in younger entrants means no succession pipeline exists. Moreover, food self-sufficiency concerns—Japan produces only 40 percent of its caloric intake domestically—add national security dimensions to agricultural workforce challenges.

Traditional farming demanded extensive physical labor, experience-based judgment about weather and soil conditions, and knowledge transmitted through apprenticeship. The farming population decline reflects younger generations' unwillingness to accept low incomes, long hours, physical hardship, and social isolation associated with agricultural work by living and working in necessarily rural areas. The question is whether technology can transform farming into work that attracts a broader demographic while maintaining or increasing productivity.

Technological Transformation: ICT Agriculture and Industry Convergence

Japan's agricultural transformation involves multiple technological threads that together redefine what it means to be a farmer. These include ICT-enabled equipment, drone technology, automated systems, and data-driven decision support—all aimed at reducing physical demands while increasing productivity and enabling rapid skill acquisition.

Komatsu's entry into agriculture exemplifies industry convergence. Originally motivated by corporate social responsibility to its home prefecture in rural Japan, Komatsu applied industrial equipment and processes to agricultural challenges. The key insight was that industrial bulldozers, equipped with the same ICT systems used in construction, could revolutionize wet rice cultivation.

Traditional wet rice cultivation required transplanting seedlings into water-flooded paddies because direct seeding produced uneven growth and vulnerability to birds. However, transplanting is labor-intensive and costly. Komatsu discovered that ICT bulldozers could make paddy surfaces almost completely flat—something previously impossible. This flat surface with precision grooving enabled direct seeding without production loss, reducing costs by approximately 40 percent.[xvii]

More significantly, the precision land preparation enabled by ICT equipment allows rapid conversion of rice paddies into dry fields for other crops. This flexibility permits responsive planting based on market prices and weather patterns—transforming areas that had been locked into traditional rice cultivation to flexible, market-responsive agriculture. The system requires not traditional farming expertise but ability to operate ICT equipment and make data-driven planting decisions.

Kubota, a Japanese firm specializing in agricultural machinery, pursued a complementary strategy focused on Silicon Valley partnerships. Establishing its Kubota Innovation Center Silicon Valley in 2021, Kubota invested in multiple “agritech” start-ups addressing specialty crop challenges. Investments included Advanced Farm Technologies (robotic fruit harvesting), Bloomfield Robotics (crop health monitoring using AI and digital imaging), and FarmWise (automated weeding), all with major development operations in inland California.[xviii] In 2024, Kubota acquired Bloomfield Robotics outright, its first acquisition orchestrated by the Silicon Valley office.[xix] Kubota made these acquisitions and partnership not simply to bring them back to Japan, but also to become a player in addressing challenges facing California as well. In this sense, California attracts not only capital, but expertise and corporate partners from around the world facing similar challenges. Japan in particular has numerous companies that fall into the pattern seen in the previous section as well: Japanese companies’ equipment manufacturing prowess combining with Silicon Valley’s software expertise.

The Japanese government’s support through the Ministry of Agriculture, Forestry and Fisheries' Smart Agriculture Project provides a crucial enabling framework for efforts such as those by Kubota. Established in 2019, the program explicitly addresses aging and declining agricultural populations. [xx] It promotes autonomous driving equipment, IoT sensors, drone deployment, and data analytics. Annual reports showcase successful implementations which create legirimacy of the projects, thereby reducing the risk for developers and adopters.[xxi]

The transformation extends beyond equipment to comprehensive systems. Automated irrigation using smartphone controls, drone-based field surveying that replaces weeks of manual measurement with twenty-minute flights, and AI-driven crop disease forecasting all reduce the knowledge barriers to farming. While iteration cycles in agriculture are necessarily slower than software or industrial machinery related products, since the physical growth of plants are involved, the clear goal is to enable novice farmers to achieve results comparable to experienced

farmers and professionals by following system recommendations based on sensor data and algorithmic analyses.

Implications for California's Agricultural Regions

California's Central Valley faces analogous agricultural workforce challenges, though less extreme than Japan's. The average age of California farmers is rising, agricultural labor remains difficult to attract, and specialty crop farming requires increasingly sophisticated management as climate patterns shift and water availability declines. The bioeconomy vision for the Central Valley emphasizes high-value agriculture, efficient resource use, and integration with biomass processing—all requiring more sophisticated management than traditional farming.

Japan's experience suggests several strategic directions for California. First, precision agriculture technologies should be viewed not merely as productivity enhancements but as workforce transformation tools. ICT-enabled equipment can enable career transitions into farming from non-agricultural backgrounds, broadening the potential labor pool. Community college agricultural programs could emphasize data analytics, systems operation, and technology integration that augment traditional farming knowledge.

Second, California's substantial venture capital and technology sectors create partnership opportunities similar to Japan's Silicon Valley collaborations. Equipment manufacturers, technology companies developing agricultural AI, and California specialty crop farmers could form consortia to develop and deploy augmentation technologies. State agricultural extension services could facilitate these partnerships while ensuring small and mid-size farmers benefit from innovations.

Third, the integration of agriculture with other bioeconomy sectors—biomass for energy production, waste stream valorization, carbon sequestration—will require farmers to think beyond traditional crop production. The skills needed increasingly resemble those of industrial operators managing complex systems rather than traditional farm labor. Workforce development initiatives should prepare for this transformation explicitly.

The water challenges facing California's inland agriculture provide a particularly compelling case for ICT agriculture adoption. Precision irrigation using sensor networks and AI-driven decision support can optimize water use while reducing labor requirements. Automated monitoring systems can manage complex water delivery across large acreages with minimal staffing. These technologies transform water management from experienced-based judgment to data-driven precision—another shift from traditional blue-collar expertise to white-collar analytical work.

Case Study 3: Transportation and Logistics—Reimagining the Professional Driver

The Transportation Labor Crisis

Japan's commercial driver shortage represents an acute near-term crisis that demands immediate technological intervention. The average ages of bus, taxi, and commercial truck drivers in 2021

were 53.0, 60.7, and 48.6, respectively.[xxii] More concerning, these professions face severe recruitment challenges due to long hours, relatively low pay, and physically demanding conditions.

Consider the specific dynamics: truck drivers worked an average of 209 hours per month in 2021 (compared to 160 hours for a standard five-day, eight-hour-per-day schedule), yet earned ¥4.46 million annually (approximately $28,000 at the early 2026 exchange rate of roughly 158 yen per dollar)—below Japan's average salary of ¥6.18 million ($38.8K). Bus drivers averaged 180 hours monthly for ¥4.04 million ($25.5K) annually. Taxi drivers worked 176 hours monthly for just ¥2.8 million ($17.6K) annually. The proportion of drivers in their twenties fell below 20 percent in the trucking industry after 2015, while drivers in their fifties and sixties increased steadily, surpassing 40 percent.[xxiii]

These conditions create a vicious cycle: poor compensation and working conditions deter younger workers, workforce aging increases safety concerns and reduces productivity, labor shortages drive up costs but companies cannot raise wages sufficiently to attract workers, service quality and availability decline. Rural areas suffer disproportionately, with bus routes disappearing and truck delivery becoming unreliable, accelerating depopulation and economic decline.

Driver Augmentation: Truck Convoys and Enhanced Vehicles

The global leaders in developing fully autonomous driving solutions that completely replace drivers are Silicon Valley firms such as Waymo and Tesla for automobiles and Aurora Innovation, Kodiak, and other for trucks. Japan's approach to trucking, however, emphasizes augmentation strategies that multiply driver productivity while maintaining human oversight and decision-making. Truck convoy systems exemplify this approach. In these systems, one truck with a human driver leads two or three driverless trucks closely following behind, digitally tethered through sensors and software. The lead driver controls the entire convoy, effectively tripling productivity—a paradigmatic Augmentation rather than Autonomous strategy.

This technology redefines the truck driver role from one of purely driving to becoming a convoy manager. Especially once the front truck is somewhat augmented such as systems keeping the truck within lanes and adaptive cruise-control that free some cognitive and physical tasks of the driver, the driver also becomes a monitor of follower vehicles while handling exceptional situations. The job requires different skills such as systems monitoring, digital troubleshooting, and coordination, but remains fundamentally human-centric. It represents a hybrid of traditional driving and white-collar systems management.

Multiple consortia of industry players, with full government support, have tested convoy technologies on public roads and expressways. By 2021, Toyota Tsusho and start-up Senshin Mobility (Advanced Smart Mobility) achieved successful tests of driverless follower trucks using Hino platforms. The program reached a milestone in 2024, when Toyota Tsusho announced new expressway demonstrations on the Shin-Tōmei Expressway, verifying "independent driverless driving between relay areas such as logistics facilities, service areas, and parking areas" and aiming for "social implementation … from fiscal 2026 onward through a joint public-private effort."[xxiv]

Full Automation: Addressing Rural Mobility Collapse

While Japan is not a leader in developing or deploying fully autonomous cars in the manner of San Francisco and Silicon Valley, various trials are underway with a focus on self-driving buses and automated driving tests that receive subsidies.

In rural areas where driver shortages threaten complete service collapse, Japan pursues full automation for specific, constrained applications. Self-driving buses on predetermined routes represent a pragmatic approach to maintaining rural mobility. Odakyu Electric Railway, in partnership with Kanagawa Prefecture and Keio University, [xxv] developed autonomous buses initially tested on university campuses before deployment on public roads in tourist areas and aging suburban communities. Odakyu, in collaboration with Enoshima Electric Railway, an Odakyu group company, began testing the buses on public roads in the Enoshima area; Enoshima, an island connected to the mainland by bridge, is a popular tourist destination.[xxvi] In February 2019, around 700 residents took part in a test drive of the buses on 1.4 kilometers of residential streets in Tama City, a suburb of Tokyo, where Odakyu has a major presence.[xxvii]

A consortium led by leading transportation firm Yamato conducted government-authorized on-road self-driving truck trials along the Shin-Tomei expressway between Surugawan-Numazu and Hamamatsu Service Areas in February 2025.[xxviii]

A distinctive supportive measure by the Japanese government is in its infrastructural support. In 2023, the government announced plans for a 100-kilometer expressway lane dedicated to self-driving vehicles. The Ministry of Economy, Trade and Industry (METI) partnered with the Ministry of Land, Infrastructure, Transportation and Tourism (MLIT) to designate this infrastructure. MLIT itself, under the direction of the Cabinet office, established a numeric goal in 2025 to have at least 100 sites for testing autonomous vehicles by the fiscal year of 2027, and to have at least 10,000 autonomous vehicles providing services by 2030.[xxix]

Applications to California's Inland Transportation Challenges

California's inland regions face distinctive transportation challenges relevant to Japan's experience. The Inland Empire functions as a logistics hub for Southern California, with massive warehouse facilities and constant truck traffic. Driver shortages impact both regional goods movement and last-mile delivery. Rural areas of the Central Valley struggle with limited public transportation, constraining workforce mobility and economic opportunity.

The bioeconomy vision for these regions involves distributed facilities processing agricultural waste, woody biomass from forest management, and other organic materials. This distributed model requires reliable logistics connecting multiple small facilities rather than traditional hub-and-spoke patterns serving large centralized plants. Driver shortages threaten this operational model's viability.

Japan's augmentation approach offers practical near-term solutions. Truck convoy systems could be tested on California's extensive highway system, particularly on Interstate 5 connecting the Central Valley with major markets. The relatively straight, well-maintained routes with limited traffic complexity provide ideal testing conditions. California's substantial autonomous vehicle

testing regulatory infrastructure, developed primarily for passenger vehicles, could be adapted for commercial convoy applications.

The workforce implications are substantial. Rather than viewing autonomous trucking technology as eliminating driver jobs, the augmentation framing suggests transformation into fleet management and monitoring positions. Workforce development programs could prepare commercial drivers for transition into convoy management, remote vehicle supervision, and logistics coordination roles. If such positions offer better working conditions such as less time on the road, more predictable hours, office-based work environments, such work could potentially attract a more varied workforce that is currently largely dependent on men of relatively young to middle ages.

Towards Workforce Transformation in California's Inland Regions

Several themes emerge consistently across Japan's sectoral transformations. First, successful technological deployment requires close collaboration between equipment manufacturers, technology companies (which can be from Silicon Valley), and end-users (construction firms, farmers, transportation companies). These partnerships combine hardware expertise, software and AI capabilities, and operational knowledge. Government plays a facilitating and de-risking role through consortia organization, early-stage funding, and regulatory adaptation.

Second, the augmentation rather than full automation approach can be more tractable in the near term while delivering immediate benefits. Full autonomy, especially in physically demanding areas still faces substantial technical challenges and regulatory hurdles. Augmentation systems that enhance human capabilities can be deployed incrementally, refined through use, and scaled as technology matures. This approach is also likely to be more politically acceptable, as it can address labor shortages rather than displacing existing workers.

Third, successful transformation requires reconceptualizing job roles and skill requirements. The goal is not making traditional jobs slightly easier but fundamentally redefining what workers do. The transformation is not sudden, but can proceed with increased levels of augmentation that build up from current deployments. Construction equipment operators become systems managers. Farmers become data analysts operating sophisticated equipment. Truck drivers become convoy supervisors. These transformed roles require different skills—digital literacy, systems thinking, analytical capability—but offer better working conditions, longer career viability, and broader accessibility to diverse demographic groups.

Policy Recommendations for California

For California policymakers and business leaders considering bioeconomy development in inland regions, Japan's experience suggests specific policy directions:

Establish Regional Technology-Workforce Consortia: Create formal partnerships linking technology companies, educational institutions, industry associations, and regional economic development organizations. These consortia could identify priority workforce challenges, coordinate technology pilot projects, develop training curricula, and facilitate knowledge sharing.

Invest in Technology Demonstration and Training Facilities: Establish regional centers where workers can experience and train on augmentation technologies before employers must commit to adoption. These facilities could showcase ICT construction equipment, precision agriculture systems, and autonomous vehicle technologies. They should offer both initial training for career entrants and upskilling for incumbent workers. Funding could come from combined state, federal, and industry sources.

Reform Workforce Development Programs: Workforce training programs can emphasize digital literacy, systems operation, and data analytics alongside traditional technical skills. Ensure programs serve incumbent workers seeking skill updates, rather than only new entrants. Particular attention should focus on attracting women, older workers, and other groups historically underrepresented in blue-collar industries.

Pursue Regulatory Modernization: Review existing regulations that may impede multi-modal service integration, constrain autonomous or convoy testing, or prevent innovative service delivery models. Establish regulatory sandboxes allowing controlled experimentation with new technologies and service models in specific geographic areas. Create expedited review processes for augmentation technologies that clearly address labor shortages without displacing existing workers.

Develop Targeted Incentive Structures: Create tax credits or direct subsidies for companies adopting augmentation technologies and investing in worker training. Prioritize bioeconomy facilities that demonstrate clear pathways for workforce development and local hiring. Establish procurement preferences for state and local construction projects utilizing ICT equipment and providing training opportunities.

Foster California-International Technology Partnerships: Facilitate partnerships between California companies and global firms pioneering augmentation technologies. Support reciprocal technology demonstrations, worker exchanges, and collaborative development projects. Leverage California's existing relationships with firms from Japan and elsewhere operating in the state to create technology deployment opportunities.

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