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Are We Building Agile Graduate Capabilities to Meet Automotive Service Industry Trends?

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Abstract

The inexorable increase in the use of electronic technology and rising user expectations of motorised transport are quickly moving the automotive service industry towards a rapidly changing environment. To maintain the ability to deal with new and emerging technologies, industry leaders will need to rethink how they will address their staffing strategies. In this research, we found that the New Zealand automotive service industry is markedly different from what it was 20 years ago, as technology in vehicles has increased due to environmental legislation and customer demands. The service industry is going through a technological revolution as new, more environmentally friendly vehicles are introduced into the fleet. Further technological complications are added as vehicle safety is improved through automation of vehicles and soon-to-become-common, fully autonomous vehicles. Service-technician training programmes must be modified to ensure that the industry is capable of dealing with high-technology vehicles when they come up for service or repair. We conclude that the increased technological complexity to achieve wider automation of vehicles requires the service industry to secure its future by continuing to re-educate its workforce now on design thinking, in preparation for the new vehicle-service environment. Small service-industry business operators must adapt to new technologies to survive, and for them the greatest challenge is funding now for the cost of training for tomorrow. Building capability in today's trainees is critical for successful transformation to future financial sustainability for businesses. The report closes with a series of recommendations and summarises that, to future-proof the industry, capability development with the right technical skills and attitude cannot be deferred, but needs to be taken head-on for business survival.

Introduction

This research is based on a review of the current automotive service industry by examining the technical skills required to undertake work and the introduction of technology that is required for autonomous vehicles in the potential future. As technological innovations are introduced, it is believed that the increasing number of electric vehicles and the introduction of different classes of autonomous vehicles will lead to a major reshaping of the automotive service industry. Autonomous vehicles will have technology to support wider usage, requiring extended skill-sets of the service technician. The current challenge for educators and trainers is to equip the potential and current workforce with the skills that will enable them to work with new technologies. Our view includes the current state of automotive-industry service skills and those that workers will need in order to deal with future technologies. Industry leaders seeking to cope with and take advantage of emerging technologies will need to manage the complex shift in staff-development programmes. The challenges will vary depending on the nature and socio-economic composition of their client base. The socio-economic issue may compromise the targeted training and education programmes to effectively upgrade technicians' skills and knowledge of newer technologies.

Without targeted interventions and bold investments, the service industry may suffer an economic reduction. For employees in the service industry, the labour market could shift towards a higher knowledge-demand occupation. Those with a lower level of education are likely to be displaced by those with a higher level of education. Current employees with a higher level of education and training are likely to be resilient to the technological changes around them.

Background

Technology is moving so fast that current skills taught in institutes of technology are not sufficient for the technician to cope with evolving technology designed to deliver improved productivity benefits. Reeve (2016) argues that high-quality technical training and education programmes must not only focus on competency in knowledge, skills and attitudes but must also equip trainees with 21st-century skills to cope with emerging occupational needs. The technological evolution will reshape the automotive service sector within the next decade and some components of the industry will shrink while others sectors will grow, and the skills associated with every service will be subject to change.

Industry leaders will have to make bold decisions in their investments, including the direction their businesses will take, the technology to be procured and the talent and training needs of the current workforce. Holland-Letz, Kloss and Müller (2019) claim that $120 billion was spent globally during 2017 and 2018 for mobility start-ups and investments as the industry prepares for the new mobility ecosystem, which will include autonomous driving, connected cars, electric vehicles and smart mobility. These investments

do not include the service and repair sector, which usually lags behind the manufacturing sector. The lag in technological knowledge and skills between the manufacturing and service industries will be a pain point for vehicle owners, who may continue to expect services from their local workshops. Customers need to prepare for the upcoming wave of change in the way their vehicles are serviced and the costs involved in maintaining their vehicles.

Educational and training institutes need to take advantage of this technological change period by building future-based learning systems to prepare current trainees to progress to more rewarding jobs. The average age of New Zealand's vehicle fleet has remained at 14 years for some time. The consistency in fleet average age means that each year the oldest technology is dropped and new technology is introduced. Although the introduction of newer vehicle technologies, such as lane-keeping and departure-assistance systems, electronic stability control and systems to manage driver fatigue, serves to mitigate loss of vehicle control, these features increase the technological complexity of the vehicles. Maintaining newer technologies requires more than an understanding of the nuts and bolts, and with service only available via large dealerships, maintenance of these vehicles will be an issue in the foreseeable future.

The future skills demand of the automotive service industry is heading for some unique challenges, where business transformations could involve redefining workforce training. The service industry also needs to invest in enhancing its resilience as the outlook of the industry is increasingly uncertain. The ones who will succeed will be those that have come to terms with the new technological paradigm that is shaping around them as the conventional training format simply won't work. The automotive service industry must develop effective, fit-for-purpose learning journeys for the workers, supported by the infrastructure to improve, grow and sustain capability development.

Research question

How can we secure the future professional competency of automotive technicians employed in the automotive service industry?

Literature review

Historically, according to Palamara (2018), vehicle manufacturing is replete with examples of technological improvements in designs to include use of computing technology to inform drivers or take over control to avoid crashes. Modern cars have multiple on-board computers and, according to Walker, Stanton and Young (2001), a technological revolution is underway that will eventually empower on-board computers with carrying out complex parts of the driving task. They further state that modern cars have up to 30 computers on board and serve as an excellent paradigm for ubiquitous computing.

Systems that are being introduced into vehicles include electric drive, energy storage systems, sophisticated electronic structures, and greater improvement in navigation and telematics systems. Telematics units provide useful data in motor vehicles by transmitting information on vehicle driving speed, distance travelled and vehicle location, and enable automated and autonomous vehicles. The cloud-based data from these vehicles can be used to run diagnostics and pre-inform service technicians prior to the arrival of vehicles at the service centre. The following literature review focuses on the determinants of future professional competency of automotive service technicians.

CLIMATE CHANGE

According to the *Social Responsibility Report* (McKinsey & Company, 2018), the world is currently facing a critical time responding to the challenges of climate change, environmental pollution and responsible use of resources. Watson (2001) reports that the earth's climate has changed considerably due to natural processes, and that the last 50 years, however, has seen more rapid change than previously recorded in human history. Nearly all research on climate change identifies the transport sector as the main contributor to greenhouse gases. Increases in world population and in transportation have contributed to the release of higher volumes of greenhouse gases than previously. To counter any further deterioration of the earth's atmosphere the United Nations Framework Convention on Climate Change has the overarching goal of holding the increase in global temperature to below two degrees. Chapman (2007) suggests that the transport sector accounts for 26 percent of global emissions and is still growing. He further states that to achieve stabilisation of greenhouse gases, new technological innovations that break dependence on fossil fuels, brought about by policy, are required. The transport manufacturing industry is working towards reducing the sector's greenhouse gas emissions.

New Zealand has the fourth highest number of motor vehicles per capita and emissions from the transport sector are responsible for 20 percent of this country's total annual greenhouse gas emissions (Ministry of Transport, 2018). Chapman (2008) argues that there is a growing sense of urgency internationally to cut emissions and New Zealand has committed to cutting transport-related emissions by 50 percent by 2040. New Zealand's energy infrastructure is mainly renewable power generation, which will make electric vehicles feasible. The electrification of transport will make a major contribution to reducing the carbon output of the transportation sector. Vehicle manufacturers are taking notice of the move that governments are now making into decarbonising, and responding by making the vehicles more efficient, with information systems that improve user efficiency and drive systems that cut emission outputs. The automotive service industry also has a critical role in maintaining the assets to operate sustainably and mitigate their impact on the environment.

TECHNOLOGY

Park Wonsoon, Mayor of Seoul (McKinsey & Company, 2019) says in his interview that the mobility of the future in his city aims to enhance the

convenience, reliability and sustainability of transportation by harnessing new technologies such as the Internet of Things, automation and artificial intelligence. The ever-evolving technology is changing the mobility world and reshaping the risk landscape. There are now well-established applications of information and computing technologies with applications in traffic data collection, transport network control, vehicle control, driver-assistance systems and other multiple applications. To realise the capability of these new technologies and transition to a sustainable and environmentally friendly transport system, there are three interrelated changes in the mobility sector. First, the change in climate is pushing governments to introduce stringent sustainability-focused laws to control and mitigate climate-changing activities. Hillman and Sandén (2008) argue that climate change cannot be solved by incremental change of current technologies, but rather a revolution of large technological systems such as the energy and transport systems. Earle (2017) supports this argument with the statement that incremental improvements are not enough to solve our current and future transport problems, but there needs to be a disruptive innovation that transforms the travel experience with a more connected, faster and on-demand system. Innovations introduced in mobility must be able to address the future changes of how people will live. To meet these government targets and customer demands, manufacturers are using technological innovations to address these concerns while still being competitive in the market. And finally the digital revolution and the speed of data through hyper-connectivity is reshaping everything, including the transport sector. However, these changes, while creating new opportunities, are also exposing the industry to new challenges and the most at risk is the after-sales service sector.

ELECTRIC VEHICLES

As reported by Hertzke, Müller, Schaufuss, Schenk and Wu (2019), the global electric-vehicle industry has accomplished major achievements, and the latest analysis of the electric-vehicle index shows the global electric-vehicle industry continues to make solid progress; however, several technological hurdles need to be overcome. Plug-in electric vehicles are growing in popularity as more efficient low-emission alternatives to conventional fuel-based automobiles (Deilami, Masoum, Moses & Masoum, 2011). Depletion of fossil-fuel oil reserves, rising fuel costs at the pump and increasing government regulations to reduce carbon dioxide levels have led to more sustainable transport technologies. According to the New Zealand Transport Agency, there were only 196 electric vehicles in January 2013 and by August 2019 this had grown exponentially to 16,031 electric vehicles registered for service (Ministry of Transport, 2019). The overall rate of adoption will depend on consumer acceptance, charging networks and price of vehicles. The price is forecast to go down over time, making electric vehicles more affordable, which will be the key incentive for consumer uptake.

Walker et al. (2001) suggest that safety, efficiency and enjoyment are the necessary drivers behind the implementation of computing technology in vehicles. Spurred by regulations, technical innovation in batteries and advances in smart-control technology have seen most manufacturers

including electric versions of their vehicles. Emadi, Lee and Rajashekara (2008) suggest that electric vehicles would also need to meet electrical power demands due to the increasing use of electronic features to improve vehicle performance, passenger comfort and safety. These vehicles are seen to have higher technology, negligible emissions and be an answer to climate change. Mwasilu, Justo, Kim, Do and Jung (2014) suggest that electric vehicles, when not in use, can be a potential for storing and supplying electricity to the national grid that is connected to intermittent renewable energy sources such as wind and solar. The integration of electric vehicles into the power grid will require planning, control technology in the vehicle and system knowledge for service requirements. To have vehicles integrated with the surrounding environment extends their use beyond just transportation of people and goods, requiring service technicians to have a broader understanding of the technology.

AUTOMATED VEHICLES

With the surge in the use of computing power, multi-agent systems and mechatronics allow vehicles to automatically function without driver input. Automated vehicles are becoming a norm on our roads and their technological features will expand steadily as acceptance by consumers increases. According to one study, automated driving will improve the efficiency of road transportation and quality of life (Kyriakidis et al., 2019). Automated vehicles are classified by the Society of Automotive Engineers International at levels 0 to 5 depending on the technology that controls their driving functions. Automation of vehicles is also referred to as Advanced Driver Assistance Systems, which currently comprise more than 40 functions. Park Wonsoon (McKinsey & Company, 2019) suggests that the future smart city will have autonomous driving, which will be a trigger point and a catalyst in transforming the way people and technology are connected. Manufacturers are continuously introducing computerised functions, and adaptive cruise control and parking assist systems are now a standard feature in a lot of new models.

A fully automated vehicle, also classed as an autonomous vehicle, is totally self-controlled and may not need driver input. Bonnefon, Shariff and Rahwan (2016) describe autonomous vehicles as having technology that is capable of reducing traffic accidents. The amount of structured data produced by automated vehicles is growing at a phenomenal pace, creating commercial intelligence and predictive analytics that can inform and improve the service industry. Autonomous vehicles have technologies that interact with other parts of the transport system, including other similar vehicles. Fagnant and Kockelman (2015) describe autonomous vehicles as potentially disruptive but also beneficial to our transport system. The potential disruption will be to the service industry, due to the higher levels of knowledge that will be required of service technicians. Gerla, Lee, Pau and Lee (2014) suggest that recent advances in communications, controls and embedded systems are paving the way to vehicles making their own decisions. Thrun (2010) suggests that autonomous-vehicle driving software factors into three functional areas: mapping sensor data into internal beliefs and predictions about the environment, making driving decisions and actuating vehicle-control systems.

This adds to the complexity of the vehicle as it has multiple sensors, records a huge amount of data, including information from other vehicles, and produces valuable information for its decisions.

INDUSTRY ADVISORS

As primary and secondary vehicle safety and driver assist systems are introduced, there is a need for industry leaders, those directly involved in the service industry, and those in the education and training sector to shift mindsets and prepare for the changes for a successful transformation to new technologies. The New Zealand Tertiary Education Commission dictates that as part of quality assurance and having programmes of study relevant to industry needs, educational and training institutes must consult industry and use feedback to make changes to their offerings. Industry advisory-group meetings, which are scheduled two or three sittings per year, are mostly conversational and provide a platform for current industry issues to be discussed. The dynamics of these meetings reflect the make-up of New Zealand's automotive service industry, which consists of a majority of small-business operators and fewer dealerships. Small-business operators normally have fewer than ten employees, and service vehicles that are out of warranty. Most small businesses currently deal with vehicles that are at or above the average age of New Zealand's vehicle fleet, however emerging technologies will soon catch up and transparency in discussing technologies is now critical.

INDUSTRY TRAINING

The *Social Responsibility Report* (2018) found that pre 2014 there were 75 million young people unemployed around the world, while at the same time 40 percent of employers could not fill vacancies. The Transport Research Board (2017) reported that the transport sector requires a highly skilled and qualified workforce, and that training and recruitment are essential for national economic security; however, training and development programmes are often hampered by limited resources as well as hiring and retention challenges. Long-term economic sustainability depends on investment in people, and the develoment of people requires immediate funding.

New Zealand training tends to be employer-managed and employer-centric, and it is deemed by the authors that it cannot effectively respond to meeting the training needs of tomorrow's technicians. The existing on-job model does not provide consistent competencies for new technicians and does not evaluate a learner's progress in a structured way. The focus is totally on current industry practice and learners do not get exposed to emerging technologies. Wu et al. (2019) argue that emerging technologies such as connected vehicles, transportation electrification and cutting-edge computing have increased efforts from policymakers, researchers and engineers to respond to transport-related energy and environmental problems.

Reeve (2016) argues that leaders involved in technical vocational education and training must prepare their students with solid knowledge and skills needed in the 21st century in the discipline they study. One of the greatest barriers to educating technicians for tomorrow is that the industry

attracts young people who often have not been academically successful in school. The reality is that no one is raising their children to be automotive technicians, but instead vying for them to excel and take on more rewarding jobs; however they fail to realise that in the future automotive technicians will be dealing with high-technology vehicles, which will lead to a financially viable employment pathway. Thus the automotive service industry struggles with developing people who will be capable of delivering the evolving service needs of tomorrow's vehicles. Without the capability-building in today's trainees, smaller service-industry providers face a gloomy future. The focus of the training industry needs to include development of sustainable careers for the young generation, with skills that they will require for tomorrow's industry needs.

Methodology

To determine future professional competency of automotive technicians, we the authors used multiple information sources including artefacts. A qualitative approach was predominantly adopted, however certain quantitative data was also reviewed to gain insights and consolidate our thoughts. Specifically, the research team reviewed current industry practice and all relevant literature including previous research, advertisements for new vehicle models and current industry meeting notes that focused on automotive service-industry training and education. Scenario 1 describes the professional competency required for current service practice. Scenario 2 has been developed using document analysis to predict industry trends and professional competencies that service technicians will use in the future. The research team selected and used:

- New technologies in upcoming vehicle models.
- Composition of industry advisory team to educational and training institutes.
- Current programmes of study for automotive service technicians.
- New Zealand funding models for training and education.
- On-board computing technologies for vehicle operation.
- Cloud-based computing technology used to support other service industries.

Findings

There is limited literature on the subject of the future motor-vehicle service industry and the impact new technologies will make, hence the focus of the research was on key drivers of technological change, current interim technology in vehicle drive systems, emerging technologies that are being

introduced in other developed countries and current training arrangements for service technicians. In the research we provide the basis of theoretical background to lay the foundation for futuristic thinking. The current practices in the automotive service industry are set out in Scenario 1. The process is totally dependent on human intervention. In Scenario 2 we have tried to portray how the future will look and its impact on the vehicle-service industry. We have included the way telematics and mobile communication systems will integrate to provide an efficient work-processing system that will drastically reduce asset downtime.

SCENARIO 1 – CURRENT INDUSTRY PRACTICE

A vehicle drives into a dealership service-centre and the driver describes the symptoms of a fault to the centre manager. The centre manager then books the vehicle in for repair. A technician is assigned to the vehicle, and then runs the diagnostics, identifies the fault and orders parts. Parts arrive the next day and repairs are completed. The technician runs further tests and prepares a report of impending failures. The repair process takes no less than two days.

SCENARIO 2 – EMERGING PRACTICE

A vehicle in use is developing a fault which is not yet detected by the user; however, using business intelligence and analytics, the vehicle sends an automatic alert to the main monitoring centre hosted by the dealership's service centre. At the same time, without human intervention, the driver is informed of the impending problem and, if there is the potential for an unsafe situation, the system warns the driver of possible shutdown. The system automatically informs the service centre of the impeding failure, orders parts for the repair, identifies the tools required, provides a service instruction for the technician and books the vehicle in for repair. By the time the vehicle arrives at the service centre, everything is prepared for carrying out the repair. As the technician repairs the vehicle, they further examine the on-board data for any other upcoming faults and carry out preventive repairs before returning the vehicle to the driver. Using analytics, trends for faults are examined and the manufacturer is provided with feedback. The system provides a seamless repair service within minimum time, reducing downtime and improving productivity for the vehicle owner and the service centre. The repair process is completed within hours of the vehicle arriving in the workshop.

Conclusion

Dealerships have larger service centres, however their numbers are low. Dealership service centres service vehicles with the latest technology, but since the vehicles are new, there is seldom any type of repair carried out. Dealerships also have the support of manufacturers, and access to information and advice from them. This arrangement mitigates their exposure to new

technologies, as manufacturers will support the sector as technology changes.

A high percentage of the service industry is made up of small operators who work on vehicles that are in the older sector of the New Zealand vehicle fleet. The focus of their work is dealing with technology that is more than 14 years old. The service sector needs to develop new business models based on changing customer vehicle technologies. Small-business operators need to start taking part in the reshaping of education and training, and invest in their employees to ensure they are prepared for the technological revolution heading in their direction. The skills and knowledge gap of technicians in servicing and repairing vehicles between average fleet age and those with emerging technologies will be a hindrance to transforming service practices. For sustained growth of the automotive service industry, interventions designed to overcome the skills gap need to be thoughtfully sequenced by embedding generic competencies in work and reinforced through educational programmes delivered by professional educators. Simply, technicians will need to know the new order of working; how to do things correctly at the appropriate time to create organisational credibility consistent with the vision of the business. There is a dire need to shift the mindsets of industry advisors to ensure training and education leads to successful transformations of technician competency, which in turn will lead to the economic survival of the service industry.

Agile graduate capabilities require being ready for change with an open mindset and adapting to innovative technologies as they are incorporated into the transport fleet.

We the authors believe that investment in training and education for the future is a fundamental necessity for sustained economic growth of the automotive service industry. It is our hope that the subject of this research will receive industry attention, followed by appropriate reframing of the training and education programmes and resources provided to implement such programmes.

Recommendations

To ensure that graduates are capable of meeting the future needs of the industry and to improve learner benefits, it is recommended that training and education programmes be employee centric, where the programmes of study not only include current technology, but are designed to prepare students for technology that is on the horizon or yet to come. To future-proof the automotive service industry in New Zealand, we make the following recommendations:

1. To build transformative capability, revise current training and education to include technology that is still in its development stage in manufacturing countries.
2. Strategically promote employment benefits and mindsets about design thinking, technological complexities and professional attributes to

prospective employees.

3. Involve all service technicians in education and retraining that is supported by all levels of the service industry.
4. Business organisations must invest in education and retraining programmes aligned to technological developments, and incentives for employees must be made available.
5. Focus investment on innovative capability development to drive technician preparedness.

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