



TRILLIUM NETWORK
FOR ADVANCED MANUFACTURING



Automation Readiness & Brampton's Advanced Manufacturing Sector

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The Trillium Network for Advanced Manufacturing is a provincially-funded non-profit organization that raises public and investment awareness of Ontario's advanced manufacturing ecosystem with the intention of supporting growth and competitiveness. Our offices are located on the campus of Western University in London.

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This report was prepared by the Trillium Network for Advanced Manufacturing in collaboration with the City of Brampton's Economic Development Office.

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Executive Summary

Advanced manufacturing is a critical component of Brampton's economy. The advanced manufacturing sector is evolving rapidly, and changes to technology, infrastructure, human resources, and government policy significantly influence investment decisions and competitiveness. Moreover, the COVID-19 pandemic has profoundly affected the trajectory of manufacturing in Brampton and across Ontario.

It is within this context that the Trillium Network for Advanced Manufacturing partnered with the City of Brampton's Economic Development Office to undertake a project to assess the extent to which Brampton manufacturers have adopted, or plan to adopt, automation, robotics, and other advanced production technologies. Within this project we also examined the composition of Brampton's manufacturing sector and identified opportunities to attract domestic and foreign direct investment.

The project is informed by three sources of data. The first includes government statistics, which we used to create a profile of Brampton's manufacturing sector. The second is a database of several hundred Brampton manufacturing establishments created from publicly available information. The third was interviews with representatives of eight Brampton-based manufacturers. Included among these were automotive, aerospace, food, beverage, pharmaceutical, automation and tooling, and packaging manufacturers. Four were Canadian-owned and four were foreign-owned. Through these interviews we gained an understanding of the trajectories, capabilities, and perspectives of manufacturers regarding automation, robotics, and advanced production technologies.

Through this work we gained valuable insight into Brampton's manufacturing sector. We learned that Brampton's manufacturing workforce is talented. We learned that Brampton's transportation and telecommunications infrastructure ensures that manufacturers are well-connected to each other, and to the rest of the GTA, Ontario, North America, and the world. Perhaps most importantly, we learned that Brampton's manufacturing sector is diverse, and that this leads to diversity in the experience of manufacturers as they related to 'automation readiness' and the adoption of automation, robotics, and advanced production technologies. While some manufacturers have made significant progress, others are lagging behind. There are several reasons why this is the case, all of which are explored in more detail in this report.

Investing in automation, robotics, and advanced production technologies (and supporting manufacturing generally) is critical to the future competitiveness of Brampton's manufacturing sector. It is similarly important to communities elsewhere in Ontario. This is especially important as we emerge from the COVID-19 pandemic and realize the full extent of its economic impact. As such, a productive and technologically sophisticated advanced manufacturing sector will be critical in generating the employment and revenue necessary to support our economy and communities on an ongoing basis.



The Importance of Manufacturing

Manufacturing is critical to Ontario's economy. In 2019, Ontario manufacturers employed 692,382 people and contributed more than \$89 billion to GDP.¹ This accounts for 11 percent of Ontario employment and 12 percent of Ontario's economic output.

In addition to these contributions, manufacturing is vital for several reasons:

- Manufacturing employees earn 11 percent more than the provincial average wage. In some segments, such as automotive and aerospace, this premium is as high as 40 percent.²
- There are strong linkages and interdependencies between manufacturing and other sectors. Agriculture, construction, transportation and logistics, and even education are closely linked to manufacturing.³
- As a result of wage premiums and upstream and downstream linkages with other industries, manufacturing activities generate additional economic activities. These activities are substantial. For example, every job in automotive assembly or upper-tier aerospace manufacturing is estimated to create six jobs elsewhere in the economy.⁴
- Manufacturers are a critical source of corporate, income, consumption, excise, and property tax revenues. In the case of automotive manufacturing, we estimated that every vehicle assembly job generates enough revenue from related economic activity to support one full-time teacher or nurse.
- The economic output, employment, and tax revenue generated by manufacturers will be critical to Ontario and its communities as we emerge from the COVID-19 pandemic.

Manufacturing is also an important source of R&D and technological advancements. In 2019, manufacturing accounted for 31 percent of Canadian private sector R&D spending.⁵ This figure, which does not include manufacturers' contributions to publicly-funded R&D conducted at post-secondary institutions and government-funded research centres (e.g. NRC), is further evidence of manufacturing's outsized contribution to Canada's economy and innovative capacity. These contributions are particularly germane to this project, which focuses on investments in automation, robotics, and other advanced production technologies.



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Brampton's Advanced Manufacturing Sector

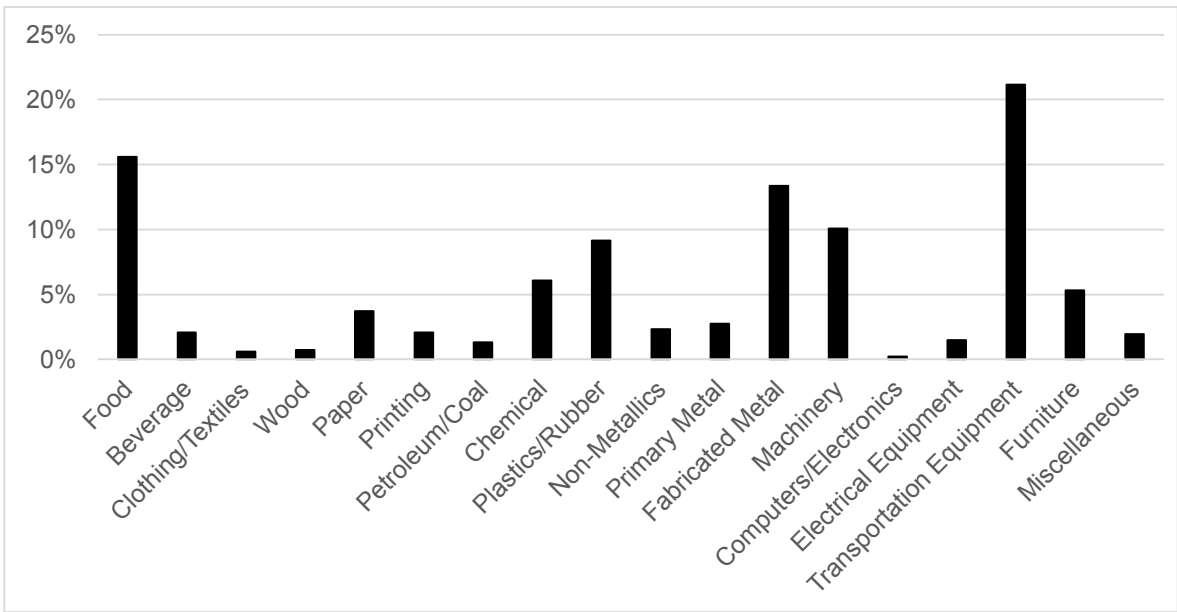
Brampton is home to hundreds of manufacturing establishments, which employ more than 40,000 people. Taken together, Brampton's manufacturing sector contributes more than \$5 billion to GDP⁶ and its employees earn more than \$2.4 billion annually. These employees pay more than \$285 million annually in federal income taxes, \$143 million in provincial income taxes, contribute more than \$109 million to CPP, and pay more than \$32 million in employment insurance premiums.⁷ In short, manufacturing makes an outsized contribution to Brampton's economy and tax base, and Brampton makes an outsized contribution to Ontario's manufacturing ecosystem and economy.

While diverse, Brampton's manufacturing sector is concentrated in several important industries (Figure 1). Not surprisingly, transportation equipment and food processing represent Brampton's

largest manufacturing industries. Transportation equipment manufacturing accounts for more than 21 percent of Brampton manufacturing employment (and substantially more in terms of output). The majority of these activities are related to vehicle assembly and automotive parts manufacturing, although Brampton is home to aerospace, rail, and heavy transportation equipment component manufacturers. Food processing is the second largest manufacturing industry in Brampton, representing more than 15 percent of manufacturing employment (Beverage manufacturing represents an additional two percent). Metal fabrication, machinery, and plastics manufacturing are also significant.

Brampton is home to a variety of large, medium-sized, and small manufacturers. Such a range of companies is generally thought to be important to a vibrant advanced manufacturing ecosystem.

Figure 1 - Brampton's Manufacturing Employment by Industry Sub-Sector



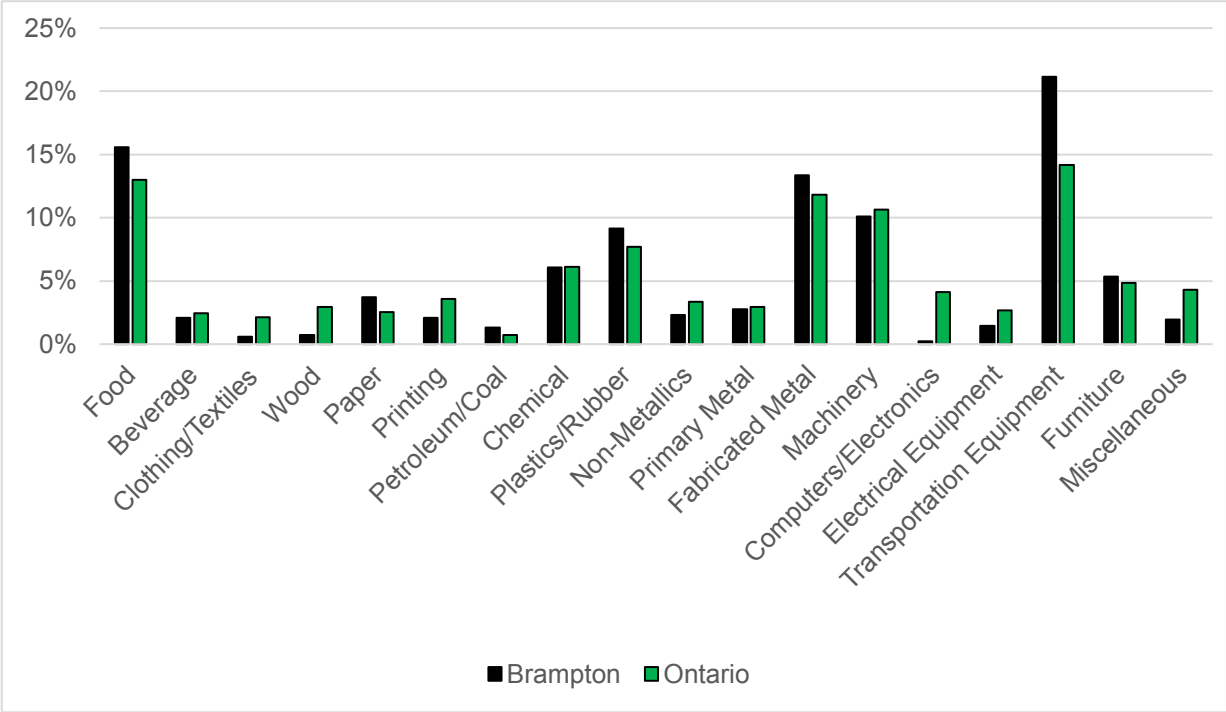
While such large entities as Stellantis, Magna, Martinrea, Maple Lodge Farms, Coca-Cola Canada Bottling, Matcor-Matsu, Olymel, Taro Pharmaceuticals, MDA, and Owens-Illinois account for a large proportion of employment and output, they are joined by hundreds of small and medium-sized manufacturers.

Brampton is also home to organizations that contribute directly to manufacturing-related innovation, training, and R&D. MDA's Brampton facility, which can track its roots back to aircraft manufacturer Avro Canada, is an important source of aerospace and robotics innovation. Magna's Promatek Research Centre is critical to the company's structural systems (Cosma) division. Sheridan's

Centre for Advanced Manufacturing Design and Technology (CAMDT) is an increasingly important node between education institutions and manufacturers, supporting R&D, innovation, and training initiatives.

Brampton plays an outsized role within Ontario's advanced manufacturing ecosystem. In addition to direct manufacturing activities, Brampton serves as a transportation and logistics hub. The distribution of manufacturing activities in Brampton is similar to those across Ontario, with some small differences (Figure 2). Namely, Brampton's manufacturing is slightly more concentrated in transportation equipment and food processing and less concentrated

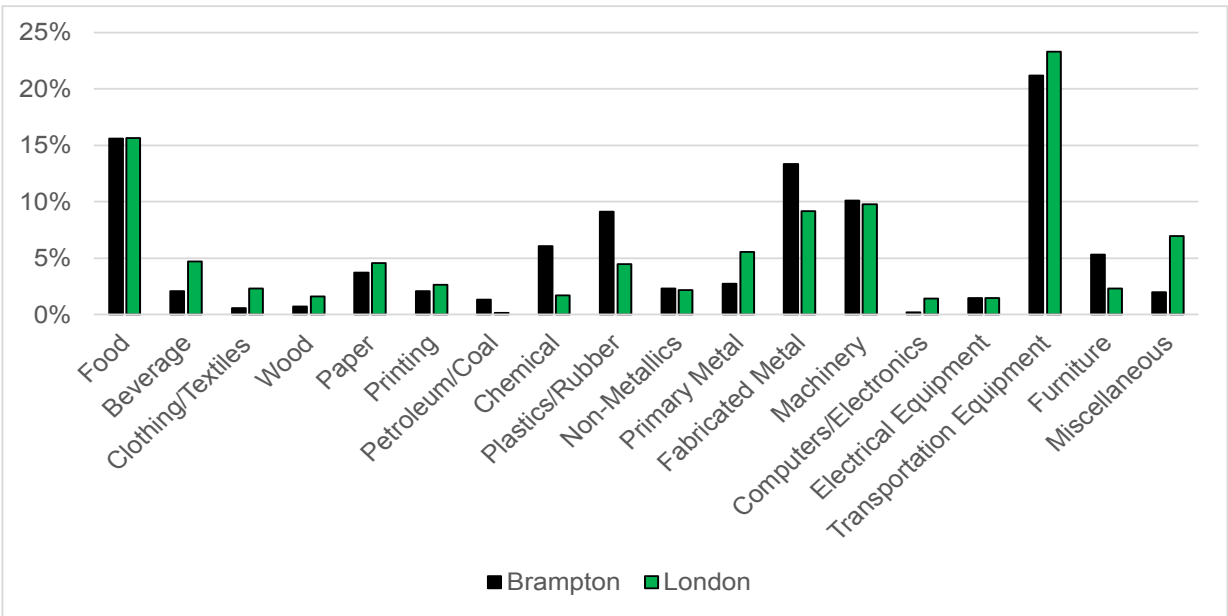
Figure 2 - Brampton and Ontario Manufacturing Employment by Sub-Sector



in clothing and textiles, wood products, and electronics. When compared to other metropolitan areas in Ontario, Brampton’s manufacturing sector most closely resembles the London Census Metropolitan Area (Figure 3). Brampton and London are similar in that they have significant transportation equipment manufacturing and food processing capabilities, and some capabilities in most other industries, save for clothing textiles and electronics.

These data are an important step in understanding the dynamics of Brampton’s manufacturing sector, the opportunities to invest in advanced production technologies, and the potential to contribute to Ontario’s economy as we emerge from the COVID-19 pandemic.

Figure 3 - Brampton and London (CMA) Manufacturing Employment by Sub-Sector



Brampton's Manufacturing & Automation Readiness

Most manufacturers, regardless of industry, size, or scope, agree that investing in advanced production technologies (including those associated with Industry 4.0) is essential to future competitiveness. However, a number of factors both encourage and constrain those investments. In this report we identify some of these factors with the help of a framework developed by Schumacher, Erol, and Shin.⁸ We then draw upon our interviews with Brampton manufacturers in order to apply a modified version of this framework to Brampton's broader manufacturing industry.

Schumacher, Erol, and Shin identify several factors that influence the adoption of advanced production technologies:

1. **Strategy.** The extent to which investments in advanced production technologies are part of a company's overarching strategy and the internal resources available to realize those investments.
2. **Ownership/Leadership.** The nature of company ownership, as well the willingness of company leaders to invest in advanced production technologies and those leaders' competence and familiarity with those technologies.
3. **Culture.** The extent to which competencies related to advanced production technologies are valued within the company, and the innovative and collaborative capacities that exist within the company.
4. **Customers/Markets.** The extent to which customers and end-users (including other manufacturers) understand, value, or require suppliers to be familiar with and adopt advanced production technologies.
5. **Products.** The nature of products manufactured, the technological sophistication of those products, and the extent to which advanced production technologies improve the production of those products.
6. **Operations.** The extent to which existing operations use advanced production technologies, and the ease with which additional advanced production technologies can be integrated into existing operations.
7. **People.** The existing levels of competence related to advanced production technologies within the company, and the extent to which the company can recruit, retain, and develop persons with such competencies.
8. **Legislation and Public Policy.** The legislations and government policies that encourage or constrain the adoption of advanced production technologies.
9. **Technology and Infrastructure.** The extent to which capital and infrastructure that supports the adoption of advanced production technologies are available.

Our interviews with Brampton manufacturers focused on better understanding these factors. While we did not engage in conversations about all nine in every interview, each provided insight into most of these factors. When combined with the framework, this insight leads to a general conclusion: investments in advanced production technologies are important, but individual manufacturers are motivated by diverse factors and face different challenges and barriers. Moreover, the nature of production differs across industries. As a result, the specific technologies that are most useful to individual manufacturers or individual manufacturing establishments vary considerably.



Strategy, Ownership/Leadership, & Culture

Investing in advanced production technologies is a substantial and long-term endeavour. The time frames associated with these investments are better-aligned with the business and operational models of some companies than others. These time frames are often well-aligned with the automotive industry, where product cycles are usually around five years. However, manufacturers in many other industries do not enjoy the same time frame to realize a return on investment (ROI). This was confirmed by several of the manufacturers we profiled.

Shorter time frames for ROI affect investments in advanced production technologies in several ways. First, they lead to smaller investments that carry lower risk, allowing companies to demonstrate ROI in one or two years. Second, those investments generally result in incremental improvements to existing production processes. Manufacturers tend to make the most progress in instances where those existing processes - themselves the result of past investments - were already highly automated. If, however, a manufacturer had not made substantial investments in that past, smaller incremental investments may not be particularly impactful, and they may continue to lag their counterparts (or fall further behind). The extent to which advanced production technologies currently exist in a production facility is therefore a good measure of the extent to which they will continue to adopt newer technologies moving forward.

Company ownership and the location of corporate headquarters also play a role in decisions to invest in advanced production technologies. Locally-owned manufacturers can generally make decisions about investments more expediently than foreign-owned manufacturers. Conversely, foreign-owned manufacturers face a more complex process when it comes to investment decisions, a process through which Canadian divisions face internal competition with other divisions of the same company for limited capital.

Customers/Markets & Products

The industry in which a manufacturer is involved and the end use of the products they manufacture influence the extent and types of advanced production technologies they might adopt. Five of the eight manufacturers that participated in this project are involved in industries that rely on mass production. In some cases - like automotive and packaging - manufacturers have few options other than high levels of automation. Moreover, their customers and supply chain partners may insist that they adopt particular technologies.

Consumer product manufacturers (e.g. food, beverage, pharmaceuticals) also rely on mass production to achieve the economies of scale necessary to remain competitive. While most achieve these economies of scale through high levels of automation, some continue to rely on lower-cost manual labour to maintain competitiveness.

The other three manufacturers that participated in this project rely on highly specialized and customized production processes. While these processes are undoubtedly sophisticated, they do not require the same levels of automation or robotics as manufacturers involved in mass production. Instead, they may invest in other technologies, including additive (e.g. 3D printing) and digital manufacturing (e.g. digital twins).

It is somewhat ironic that the companies that manufacture and integrate advanced production technologies were the least automated of the manufacturers that participated in this project. This, however, is a testament to the nature of manufacturing the custom and specialized advanced production technologies adopted by modern manufacturers.

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Operations

The level of technology in manufacturers' existing operations affects the nature and extent to which they can adopt and integrate other advanced production technologies. As mentioned, manufacturers that have invested in such technologies are more likely to make improvements to those technologies, while those that lag their counterparts are less likely to do so. One of the reasons for this is that it can be challenging to integrate new and leading-edge technologies into an environment that is not highly automated or advanced. This has much to do with the increasingly interconnected nature of advanced manufacturing, as many advanced production technologies do not easily operate alongside less advanced production technologies.

While arguments for incremental improvements that do not require a manufacturer to raze an entire production facility to adopt a suite of advanced production technologies remain valid (to a degree), the rate at which already-advanced facilities adopt new technologies tends to outpace the rate of adoption in less advanced facilities. Incremental improvements are, therefore, more relevant for smaller companies or for those with medium-to-high levels of automation. In contrast, more comprehensive improvements may be necessary for larger facilities that lack advanced production technologies. This can be disruptive (or unfeasible) for larger manufacturers that are busy and operate at a scale where they can not afford downtime.



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People

The availability and cost of labour affect manufacturers' decisions to adopt advanced production technologies. In many cases, the availability of lower-paid labour inhibits the adoption of such technologies, as those employees serve as a substitute for capital investments. Conversely, tight labour markets for lower-paid employees can hasten the adoption of advanced production technologies.

The latter situation is increasingly the reality for manufacturers in Brampton and across southern Ontario. As manufacturers compete with each other, and with other sectors (e.g. fulfilment, logistics, retail), for lower-paid employees, and as challenges associated with the aging workforce and impending retirements loom, the need to adopt advanced production technologies becomes increasingly evident.

Adopting advanced production technologies as a substitute for lower-paid employees is often easier said than done. Besides the factors mentioned above, such as support from company leaders and production processes that are well-suited to automation, the availability of highly-educated and technologically-savvy personnel may encourage investments in advanced production technologies. Such persons are, however, increasingly in short supply and high demand.

In a tight labour market, it is incumbent on manufacturers to provide competitive remuneration and create an environment that supports employee development. The manufacturers that participated in this project had a diversity of experiences related to labour markets and advanced production technologies. Some paid exceptionally well and relied almost exclusively on highly-educated personnel.

These manufacturers faced relatively few challenges related to recruitment and retention. By extension, their employees facilitated the adoption and integration of advanced production technologies. Those that relied on lower-paid employees faced substantial recruitment and retention challenges. When combined with lower-than-average levels of automation and production processes that are not easily automated, their employees constrained their potential to invest in advanced production technologies.

Legislation and Public Policy

The legislative and public policy environment in which manufacturers operate can encourage or constrain investments in advanced production technologies. Public investments in secondary and post-secondary education institutions were perceived to be critical in encouraging investments in advanced production technologies. In Brampton, this included Sheridan College's Centre for Advanced Manufacturing Design and Technology (CAMDT) and Magna Skilled Trades Centre.

The representatives of the manufacturers that participated in this project generally agreed that the quality of education and training of engineers, trades, and other technical occupations in Ontario was sufficient. They were more concerned, however, with what many perceived to be an insufficient quantity of graduates from these programs. They also noted that they were generally aware of federal and provincial support for investments in advanced production technologies, but that those supports did not significantly influence their decisions to invest (or not invest) in such technologies.

The availability of broadband internet is important for manufacturers seeking to adopt digital and connected production technologies (i.e. Industry 4.0).

Regulatory burdens can influence investments in advanced production technologies. This is especially the case in the food, beverage, and pharmaceutical manufacturing industries, which are all subject to significant regulatory oversight. This oversight requires manufacturers to dedicate resources to ensure regulatory compliance. Some manufacturers noted that they are so preoccupied with ensuring they complied with regulations that they had few resources left to upgrade their production technologies. Conversely, others noted that they invested in advanced production technologies as a means to ease the burdens associated with compliance. This raises an interesting question about the potential to automate non-production activities related to compliance, human resources, or logistics.

Technology and Infrastructure

Advanced production technologies are often best conceived of as a solution to a manufacturing problem. That problem may be related to productivity, traceability, or quality. However, many of these problems are not easily solved; if they were, they would have been solved already. The nature of the 'problem' therefore influences the likelihood that a technological solution exists. The more complex the problem, the less likely a solution is readily available. Manufacturing activities that are unpredictable, geometrically complex, or require a sensitive touch tend to be difficult to solve via advanced production technologies.

The most highly-automated manufacturers that participated in this project were not immediately concerned about the extent to which their production processes were automated. Rather, they were more concerned with their secondary operations, namely packaging. In these cases, the specific technologies necessary to solve their packaging-related problem did not immediately exist and the work could be done easily by lower-paid employees. The motivation to automate these functions was less immediate than other operational issues. That said, this calculus has changed as the market for lower-paid labour tightens and as new technologies emerge.

Infrastructure also plays a role in encouraging and constraining investments in advanced production technologies. The availability of broadband internet is important for manufacturers seeking to adopt digital and connected production technologies (i.e. Industry 4.0). Improving internet infrastructure, which is a priority for many Ontario communities, did not appear to be a concern in an urban environment like Brampton. In this respect, Brampton and other urban environments may have a competitive advantage vis-a-vis other communities outside of major population centres.

Discussion and Conclusion

The diversity of Brampton's manufacturing sector leads to diverse experiences as they relate to the adoption of advanced production technologies. These diverse experiences are closely related to several factors, including the industries in which manufacturers are involved, company ownership, and labour markets. While this report is based primarily on the experiences of Brampton manufacturers, the conclusions are applicable to other Ontario communities.

Most transportation equipment manufacturers (i.e. automotive, aerospace, and rail) have made at least moderate investments in advanced production technologies. These investments, which average over \$17,000 per employee annually, are generally necessary to operate in a high-wage environment like Ontario.⁹

Within the transportation equipment manufacturing industry, certain production technologies are mandated by corporate headquarters or customers, which is a factor in these higher-than-average investments. The presence of Stellantis and the divisions of several globally-competitive suppliers (e.g. Magna, Martinrea, Faurecia, Alstom) in Brampton also play a role in the adoption of advanced production technologies by transportation equipment manufacturers.

The level of automation and investment in advanced production technologies differs considerably in other industries. This is especially the case in food processing, where such investments are considerably lower in nominal and relative (i.e. per employee terms). Many manufacturers, including food processors, invest extensively in advanced production technologies. In fact, a recent report found that in 2020 North American life sciences, food, and consumer goods manufacturers adopted robots at a greater pace than automotive manufacturers for the first time ever.¹⁰ While this may be a COVID-related anomaly or simply a matter of other industries playing catch-up, it demonstrates that non-automotive manufacturers are becoming increasingly competent - or at least interested - in robotics and other advanced production technologies.

The adoption of advanced production technologies in the food processing industry, however, is not widespread, nor is it uniform. Many food processors have not invested and have no immediate plans to do so. Rather, they rely on lower-wage employees and a demand for foodstuffs in the highly-populated Toronto area that cannot be easily serviced by manufacturers from outside Ontario. These manufacturers present both an opportunity (i.e. they could become more competitive through investments in advanced production technologies) and a challenge (i.e. if they do not invest in advanced production technologies they risk falling behind) moving forward.

The project also allows us to make several higher-level conclusions with broad applications:

- Adopting advanced production technologies is a precondition for growth and competitiveness in most segments of manufacturing.
- Advanced production technologies are no longer simply a replacement for labour. Rather, investing in advanced production technologies is a solution to ongoing and evolving labour and skills shortages.
- Investing in advanced production technologies is important, but those investments need to fit specific contexts. Manufacturers should not rush into such investments without first determining if they are a good fit.
- Not every manufacturer will adopt the same technology, nor will they adopt technologies at the same pace. In many instances, certain technologies will never be relevant to a particular manufacturer or industry.
- Large and multi-divisional manufacturers, especially those that are foreign-owned, must compete not only with other manufacturers, but with other divisions within their own company. As a result, they must be able to make a case for localized investments. Local stakeholders, including municipal economic development professionals play an essential role in helping them make that case.
- Access to talent is critical to competitiveness and ability to invest in advanced production technologies. However, that talent is increasingly scarce. Developing talented personnel with an interest in advanced manufacturing may emerge as a top policy priority in the near future (if it hasn't already).
- Production activities appear to be relatively easy to automate, and it is many of the peripheral activities done by lower-wage employees - such as packaging - that present challenges. Some of the participants in this study noted that they would be unlikely to invest in advanced production technologies if they had reliable access to lower-paid employees on an ongoing basis. In this respect we offer an alternative perspective to studies that identify the lowest-skilled work as the most likely to be automated.

References

¹ Statistics Canada Tables 14-10-0202-01 and 36-10-0402-01.

² Statistics Canada Table 14-10-0204-01.

³ This is evident throughout Brampton in the automotive (e.g. Stellantis and syncreon), food processing (e.g. Maple Lodge Farms), beverage (Coca-Cola), and packaging (e.g. Menasha Packaging) industries.

⁴ See CAR Group, 2015, 'Contribution of the Automotive Industry to the Economies of all Fifty States and the United States' and Mordue G. and B. Sweeney (2019), 'The Economic Contributions of the Japanese-Brand Automotive Industry in Canada, 2001-2018.'

⁵ Statistics Canada Table 27-10-0333-01.

⁶ Author's calculations, using our estimate of 40,000 employees and Statistics Canada Tables 36-10-0402-01 and 14-10-0202-01.

⁷ Calculations based on 2019 income tax, CPP contributions, and EI premiums for persons earning \$60,491 annually (average weekly earnings for manufacturing employees x 52; Statistics Canada Table 14-10-0204-01). Based on 40,000 employees.

⁸ Schumacher, A., S. Erol, and W. Sihn (2016) A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises. *Procedia CIRP*, 52, pp. 161-166.

⁹ Statistics Canada tables 34-10-0035-01 and 14-10-0202-01, authors' calculations.

¹⁰ Association for Advancing Automation (A3). 'Yearly non-automotive robotic orders higher than automotive orders.' 28 January 2021. Available online: <https://www.a3automate.org/press/for-first-time-on-record-yearly-non-automotive-robotic-orders-higher-than-automotive-orders/>

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