

WHAT IS ADVANCED MANUFACTURING?

A recent report from Canada's <u>Economic Strategy Tables</u> recommends that 'All manufacturing in Canada should be advanced manufacturing!' We tend to agree.

The report, however, does not actually define advanced manufacturing despite invoking the term no less than 42 times. The practice of using the term 'advanced manufacturing' without defining it is common. Last year, the Trillium Network pointed out that, at best, no <u>consensus definition</u> of advanced manufacturing exists. In light of this, our board of directors encouraged us to define advanced manufacturing on our terms to guide our efforts and those of our partners that seek to support manufacturers throughout Ontario and across Canada.

At the highest level, advanced manufacturing is "the use of innovative technologies to improve products or processes, with the relevant technology being described as 'advanced'." (Thanks, <u>Wikipedia</u>). Innovative technologies are central to advanced manufacturing. Agreed.

A <u>BCG</u> report provides more insight: 'The term *advanced manufacturing* has been around for decades and means many things to many people. We define advanced-manufacturing technologies as a set of highly flexible, data-enabled, and cost-efficient manufacturing processes.' There are three important points here. First, the term advanced manufacturing is not new. Second, no consensus definition exists. Third, contemporary advanced manufacturing involves using data-enabled technologies, many of which are synonymous with Industry 4.0.

The U.S. Food and Drug Administration (FDA) recently provided some <u>valuable perspective</u> on the question. From that vantage point, advanced manufacturing is 'a collective term for new medical product manufacturing technologies that can improve drug quality, address shortages of medicine, and speed time-to-market.' They also note that 'Every field has a different set of production techniques that are considered advanced. They often: 1) integrate novel technological approaches, 2) use established techniques in a new or innovative way, or 3) apply production methods in a new domain where there are no defined best practices or experience.'

Three concepts within the FDA's definition are welcome and apply to advanced manufacturing more broadly. First, there must be something new or novel about a technology or its application for it to be considered advanced. Second, advanced manufacturing techniques differ based on context or industry. What may be advanced in pharmaceutical manufacturing may not be advanced in aerospace, and vice-versa. Third, advanced manufacturing technologies are those applied to solve a particular problem. In the FDA's case, these are related to drug quality and shortages of medicine. The idea that advanced manufacturing technologies should be developed and deployed purposefully–to address problems, and improve societal well-being–is central to our definition.

Although the Economic Strategy Table report does not define advanced manufacturing, it offers two important takeaways. First, the report assumes that not all manufacturing is advanced. Some manufacturers, and some industries, are far more advanced than others. Second, it concludes that advanced manufacturing is 'innovative, fair, and sustainable.' We take this to mean that in addition to technological innovation, advanced manufacturers treat employees well and adhere to good ESG practices.

Advanced manufacturing therefore involves the successful achievement of business objectives by developing, producing, or adopting new and novel technologies. Today, many of these technologies are digitally-based and associated with Industry 4.0. In the future they may build on a foundation of digital manufacturing and include technologies associated with <u>cognitive computing and Industry 5.0</u>. These technologies are related to manufacturing process innovation, to product and material innovation, or to other elements of the business, such as human resources, logistics, or finances. It is important to note that advanced manufacturers do not develop, produce, or adopt these technologies for technology's sake. Rather, they do so to achieve specific business objectives and, similar to the FDA's definition, to address a particular problem or achieve progress with societal well-being in mind. Finally, advanced manufacturers adhere to good ESG and employment practices.

In short, our definition of advanced manufacturing features three pillars:

- 1. Technological innovation that is new and novel in pursuit of business objectives that aims to;
- 2. Solve problems that improve societal well-being, while;
- 3. Adhering to good ESG and employment practices.

Measuring all of this can be challenging. We have, however, developed a technique to do so at an industry level. The primary metrics that we focus on include productivity, investment, R&D intensity, STEM intensity, and employee earnings.¹ This helps locate Ontario's advanced manufacturing strengths and identify those industries that require more support.

Based on our analysis, the industries where advanced manufacturing is **most common** include pharmaceuticals, chemicals, aerospace, petroleum (i.e oil refineries), and machinery (i.e. the companies that design, produce, and integrate advanced manufacturing technologies).

This does not mean that advanced manufacturing is absent in other industries. In fact, the Trillium Network aims to identify and learn from leading advanced manufacturers in these very industries, as evidenced by our profiles of such companies as <u>Myant</u>, <u>QTK Fine Cabinetry</u>, and <u>Ozery Bakery</u>.

If the Trillium Network and our partners hope to raise awareness of advanced manufacturing in Ontario, support the growth and competitiveness of advanced manufacturers, and promote advanced manufacturing as a career choice, it is important to clearly define what advanced manufacturing is (and what it is not). Ontario manufacturers face challenges related to productivity and tight labour markets. Advanced manufacturing technologies offer a solution to both challenges in that they simultaneously increase productivity and business performance while improving job quality. Moreover, advanced manufacturing technologies are being deployed throughout the province to address a series of societal issues, including housing, pollution, food insecurity, and shortages of medicine and PPE.

We welcome further discussion and debate related to our definition of advanced manufacturing, especially when that discussion and debate is informed by data. Please <u>contact us</u> to learn more.

¹ Productivity is measured as GDP per employee relative to the average for all Ontario industries (i.e. an industry receives a check mark if it is more productive than the average for all industries). Productivity Δ is measured by the average increase in productivity of an industry since 2010 relative to the average for all Ontario industries. CapEx is measured as Capital Expenditures per employee relative to the average for all Ontario industries. R&D is measured as Business Enterprise R&D expenditures as a % of GDP relative to the average for all Canadian industries. STEM is measured as the proportion of employees in science, engineering, technology/technician, and mathematical occupations in an industry relative to the average for all Ontario industries in an industry relative to average weekly earnings for all Ontarians. Sources include Statistics Canada Tables 14-10-0202-01, 36-10-0402-01, 34-10-0035-01, 27-10-0333-01, 14-10-0204-01.

Advanced Manufacturing Metrics, Select Industries

Industry	Productivity	Productivity ∆	CapEx	R&D	STEM	Earnings
Pharmaceuticals	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark
Chemical	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark
Aerospace	\checkmark		\checkmark	\checkmark	\checkmark	\checkmark
Machinery	\checkmark	\checkmark		\checkmark	\checkmark	\checkmark
Petroleum	\checkmark		\checkmark	\checkmark	\checkmark	\checkmark
Primary Metals	\checkmark		\checkmark	\checkmark		\checkmark
Vehicle Assembly	\checkmark		\checkmark	\checkmark		\checkmark
Electronics		\checkmark		\checkmark	\checkmark	\checkmark
Non-Metallics	\checkmark	\checkmark				\checkmark
Automotive Parts	\checkmark	\checkmark			\checkmark	
Other Transportation	\checkmark					\checkmark
Food	\checkmark	\checkmark				
Wood Products		\checkmark		\checkmark		
Paper	\checkmark					\checkmark
Beverage	\checkmark					
Textiles				\checkmark		
Clothing		\checkmark				
Furniture		\checkmark				
Miscellaneous		\checkmark				
Printing						
Plastics and Rubber						
Fabricated Metal						