Advanced Manufacturing Note

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The Research Question

Advanced manufacturing can best be defined as the combination of advanced materials and software. It ranges from 3D printing to leading edge microstructural manufacturing. The research question is how the availability of these technologies produces changes in the production process as well as the organization of traditional industries. Against this background, new digital opportunities are also suggested for existing and new entrant IT firms.

The summary conclusion is that new digital opportunities are arising around the merging of manufacturing and design. However, particularly with respect to 3D printing the opportunity is broad but not deep. Rather in production itself, it is in the supporting technologies that most of the digitization impact is likely to happen in the near term.

Advanced Materials

In the day, manufacturing production entailed taking a bulk commodity like a slab of steel and basically changing its geometry into a final product: a car, refrigerator etc. This was a macrostructural transformation process. In the economy of today, the critical importance of new materials is not only that they are stronger and lighter and therefore assist lightweighting to meet new fuel standards in automotive for instance but that they enable new geometries. This is microstructural manufacturing because the composition of the materials at the nano level determines the performance of the final product. This kind of production ultimately changes the industrial organization of manufacturing industries as well. The linkage to new geometries means that the traditional boundary between manufacturing and design is blurring.

Additive Manufacturing

Additive manufacturing or 3D printing has broad applications but it has significant limits related to the materials involved. Resins and polymers are the most advanced, Metallics lag behind. For these reasons, the most common applications of 3D printing in manufacturing are related to prototyping and product market development. These are important in reducing product time-to-market. It also means that the nature of the emerging firms are often in the form of service bureaus rather than stand alone manufacturers. Within metallics, the use of 3D printing for maintenance and replacement of production tools within industrial units is starting to emerge where there are limited volumes required.

Additive Manufacturing and Policy

While 3D printing is widely endorsed for diffusion across many industries, Canada has made it innovation policy bet in a specific, limited way. Unlike the centralized US initiatives like American Makes, Canada has sought to promote AM for SMEs by using community colleges as the preferred partners and anchors for their related regional industrial commons. By providing both information and working capital to private sector partners, these programs should mitigate the so-called "valley of death" in local ecosystems. There are many successful individual cases of partnership i.e. the provision of private goods. However, doubts still remain about the ability of decentralized local community colleges to provide aid that is both sufficient and appropriate to achieve the public good of systemic mitigation of the risks of AM adoption and the increase of manufacturing capacity in Canada.

Traditional Manufacturing

The impact of ICT in traditional manufacturing has accelerated the process of changing the boundaries of the firm and extending supply chains in ways that now challenge the established models of value creation.

The classic industrial corporation of the 20th century was a hierarchy led primarily by indigenous innovation, a central laboratory such as Bell Labs, Stelco Research, etc. The growth of extended supply chains have stretched this out into a networked industrial and innovation framework. It is not unusual for 80% of the final product to be produced in the supply chain. These networks are often comprised of SME firms who do most of the actual manufacturing, value creation and innovation. Therefore the technical and cognitive capacities of these SME firms is a critical factor for policy.

ICT has been at the centre of this unfolding of supply chains. At the same time it is a potential threat because the ICT partners could also, by control of the digital architecture, production and customer data, be able to extract the value creation to themselves, to the detriment of the OEMs and supply chain firms. We call this value migration.

Changes in the firm have been accompanied by changes in the public research infrastructure that supports them. In the day, the clients of a Federal materials technology lab were the major materials producers and manufacturers such as Inco, Stelco, Alcan, Ford and General Motors. Today, the major partners are predominately supply chain firms, many of whom are a set of SMEs with advanced capabilities in software, design and computer-assisted manufacturing. In automotive for instance, the estimate is 8-10%.

Network failures have been identified as a reason for the lock-in of old industrial regions in mature technological trajectories. Recently, policy-makers, civil society and private sector actors, have begun to support the introduction of more associative arrangements in traditionally non-coordinated economies, such as the US, UK and Canada. These collaborative projects often lie at the higher end of the TRL's scale (4-7), strongly oriented to near-term commercialization in assisting companies to move toward widespread technology adoption. Nonetheless, there are noticeable variations in how these coordination arrangements have emerged in various institutional settings among the competing regions, which is missing from national level studies of evolving industrial policies. As the evidence from our research suggests, these associative

arrangements differ among various regions in Europe and North America depending on the role played by public and private sector actors and existing structural and institutional constraints.

Conclusion

There are significant opportunities for existing and new ITC firms located in geographic and relational proximity to Canada's existing manufacturing clusters. However, few of the manufacturing supply chain firms have the technical capacities to effectively implement the new technologies and optimally collaborate with their ITC partners.

The major new digital opportunities are arising around the merging of manufacturing and design. However, particularly with respect to 3D printing the opportunity is broad but not deep. Rather in production itself, it is in the supporting technologies that most of the digitization impact is likely to happen in the near term.

More broadly, Canada has a major under-utilized opportunity to gain a global competitive advantage by linking its huge mineral resource base to its manufacturing base. However, the linkages between digitization of ore bodies, metallurgy, structural metallurgy to design and manufacturing have yet to be made.