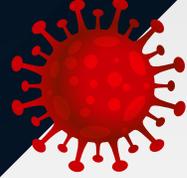
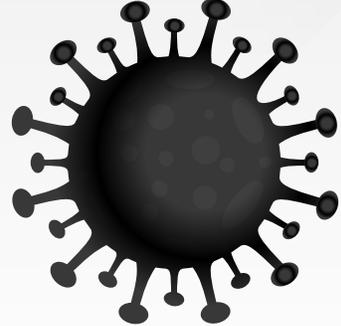
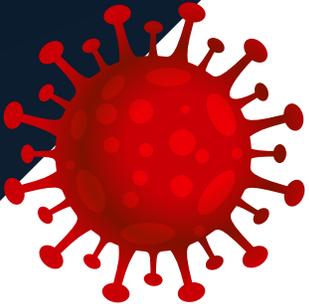
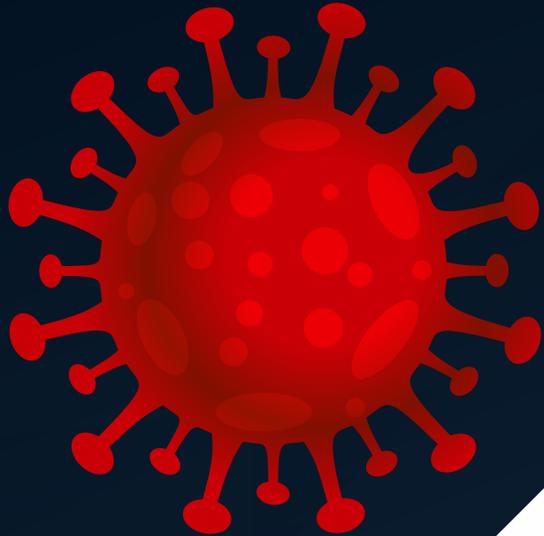




ÉCOLE DE
TECHNOLOGIE
SUPÉRIEURE
Université du Québec



RETOOLING FOR COVID-19

A Feasibility Framework for SMEs

Aamirah Mohammed Ashraf, M.A.Sc., Research Associate
Jean-Pierre Kenne, P.Eng, PhD, Professor
Lucas Hof, P.Eng., PhD, Associate Professor

April 2020



ACKNOWLEDGEMENTS

The work presented in this paper was carried out with the support of an NSERC grant at the Department of Mechanical Engineering at École de technologie supérieure (ÉTS) in Montreal, Canada. This work has greatly benefited from the appreciation and encouragement of the Office of Research at ETS.

The authors wish to thank Marie-Josée Blais, Director of Strategy and Research Development at ÉTS, for the encouragement and support of this work.

The authors also thank Mr. Mohammed Ashraf, SAP MENA and Mr. Jack-Eric Vandenbroucke, P.Eng., CMfgE, from the Office of Research at ETS for their review and insightful comments toward improving the relevance of this work.

TABLE of Contents

Retooling for COVID-19?	4
What are the requirements?	4
Which of the products required are close to your traditional product line and expertise?	4
What quantities are required?	5
Suppliers and Supply Chain Security	6
Assessing Manufacturing Capabilities	6
Production Capabilities	7
Collaboration vs. Designing Your Own Product	7
Developing New Product Designs	8
Applications of this Paper for Industries and Research Groups	8
Conclusion and Recommendations	9
Article Links	10

RETOOLING for COVID-19?

With the spread of COVID-19, there is an accelerating demand for medical supplies and equipment. Manufacturing companies from all sectors and industries want to switch production from their conventional products to the medical items most needed on the front lines, a process known as retooling or repurposing. There is a real need for quick response to this demand and the government is counting on research and innovation to guide this reconfiguration of manufacturing, as evidenced by its widespread support for research programs and funding initiatives ^[1].

Most of the larger corporations such as [Ford](#), [GM](#) and [Tesla](#) have more versatile manufacturing capacities and are already embarking on strategic reconfiguration of their production facilities. Their advanced production capabilities allow them to take on the production of medical equipment such as mechanical ventilators, transmission-monitoring and testing equipment ^[2] ^[3].

However, many Small and Medium Enterprises (SMEs) and medium sized manufacturing plants are struggling with how they can convert or “retool” their business to produce essential products at this crucial time. With strategic and collaborative retooling, these businesses can not only produce new medical supplies such as masks, gloves and face shields, but also support the production of complex medical equipment at larger corporations ^[4].

In order for the retooling process to be quick, efficient and productive, it must begin with a primary step wherein each company must strategically decide:

- what their potential is,
- what resources they have, and
- how to optimize the unique skills of their workforce.

This paper presents a framework to assist small and medium businesses with guiding questions and ideas to help them identify their true potential and how they can successfully contribute during the COVID-19 pandemic.

What are the requirements?

Before beginning any repurposing initiative, it is important to identify precisely what supplies should be produced during the pandemic. The first step is to identify and list the current requirements. This information can be collected directly from health care institutions or from government websites listing procurement needs during the pandemic.

Currently the requirements can be divided into categories of medical supplies such as test tubes, trays, swabs, personal protective equipment (PPE) such as masks, gowns and goggles, and medical equipment including certified respirators and ventilators.

Other than the physical items required by hospitals, indirect logistical problems are also arising during this pandemic, such as a shortage of electrical wall sockets to power their ventilators. Solving such issues may require strategic redesign or alternatives to existing products.

Which of the products required are close to your traditional product line and expertise?

Once the required products have been itemized, the next step is to align these items with your traditional product line and analyze which products are most similar ^[5]. Criteria for judging similarity could include raw material, complexity of design or production method. For example, if you are a textiles company, perhaps you can look into producing medical grade fabrics for masks. If you are a fashion designer with a tailoring warehouse, similar products for your company might be masks or hospital gowns. An example of this is Canada Goose’s Gown Response Program ^[6]. Another example is [Dyson](#) ^[7], which used its expertise in air flow to produce a ventilator design within 10 days.

What quantities are required?

Once you've narrowed down a list of required medical items aligned with your traditional product lines, the next step is to gather data on the projected quantities that will be required. Having this information will assist in developing production targets.

In addition to determining quantities, it is also important to research existing methods of procurement and estimate how much of the market demand is already being met. By doing this, you can calculate how much of the unmet demand your company can help fulfill, and then scale production accordingly.

Existing procurement methods can include:

Imports: Find out if imports for your selected items are still occurring during the pandemic, and what quantities are likely to be imported in the coming months.

Original Manufacturers: Companies dedicated to medical supplies are already scaling up their production. Examples of this are [Thornhill Medical](#) ^[8] and [Medtronic](#) ^[9]. Since these companies already have all the medical certifications required, their response time to get products out the door is quicker. It is important to find out how much market demand they are able to meet, and how much demand will remain, before you decide to repurpose your production lines.

Companies who have already switched over: Other non-medical companies may have already begun production of an item that interests you ^{[10] [11]}. It is essential to list these companies and attempt to find out their production capacity.

After listing all the above mentioned procurement methods and their combined capacity to fulfill market demand, you can predict what percent of the forecast market remains unfulfilled.

Can you exploit economies of scale? What part of the demand can your company meet? Is it profitable enough for your company to begin production of parts?

This process will guide you on the real quantities needed and enable a cost-benefit analysis of which products are not only greatly in shortage right now, but will make it worthwhile for you to retool your production lines.

While it is important for companies to help make necessary supplies during the crisis, it is more important for them to make intelligent strategic decisions about which medical products they will fabricate on their repurposed production lines. It must be remembered that most medical products will need time for both certification and retooling. The product you choose should have a quantifiable supply gap in order for your repurposing to be useful to the community and economically viable for your company.

Suppliers and Supply Chain Security

Once you have identified a supply gap for a medical product that fits well with your traditional manufacturing, the next step is to identify what raw materials or supplier parts are required and how to secure suppliers.

While this is a relatively easy task in conventional times, it is quite the opposite during the pandemic. Given temporary closures of supplier companies and a collective slowdown of logistics companies, it is important to strategically plan for which suppliers are fast, reliable and feasible to work with. In fact, it has been reported that 94% of Fortune 1000 companies are currently facing supply chain disruptions due to the pandemic crisis ^[12].

Manufacturing companies can work with their traditional suppliers to repurpose the materials they produce and ensure their suppliers remain open for business to produce the quantities required. However, if suppliers are overseas, shipping and logistics might cause delays that must be factored in. Delays in supply chains are causing production delays for crucial medical supplies. For this reason, an article by WE Forum calls for “aggressive evaluation” of supplier options that are near-shore and thus more reliable. Opting for near-shore or local suppliers could also mean that both buyer and supplier are subject to the same legal regulations under the COVID crisis. The implicit mutual understanding will facilitate communication and the conclusion of agreements ^[13].

Assessing Manufacturing Capabilities

Many companies looking into producing medical equipment such as ventilators may find it more efficient and productive to collaborate with existing medical manufacturers or produce essential parts, depending on their production capabilities. Many medical companies are willing to share their patented designs with companies seeking collaboration. Other companies are utilizing their Research and Development capabilities to produce their own designs and 3D models for essential medical equipment required. However, the new designs may need to achieve medical certifications before they can be commercialized.

Once you have determined what items your company can produce, it is important to assess how you want to manufacture these - in collaboration with other companies using existing designs, or independently by developing new designs.

Here are some questions to assist with supplier selection:

- Which suppliers are open for business? Will they be subject to government shut-downs in the future? Working together with suppliers and putting logistics contracts in place can give suppliers the confidence to remain open for business, and even repurpose their production if required. Contracts can also serve as financial guarantees for obtaining loans or resources needed to ramp up production to required capacity^[14]. As such, they are valuable to both customers and suppliers.
- Are they capable of producing the required quantities? As mentioned in a recent article by WE Forum, it is important to share data on existing inventories as well as production capacity across all levels of supply chains to effectively redesign your supply chain for resilience in the face of disruptions ^[14].
- Are they able to produce materials that can meet medical standards? If needed, are they capable of producing an altered version of supplies to satisfy medical standards? For example, can a traditional textile supplier produce the fabric needed for N-95 masks? Can a supplier of plastics produce the raw materials needed to make medical grade test tubes and laboratory equipment?

Production Capabilities

Production capabilities include all the machinery, tooling and skilled workforce available at your company. Having a short list of all the available machines and their functionality helps provide a quick overview of which machines can produce new designs and which are dedicated to specific parts only. For example, facilities with CNC, laser cutting and injection molding capabilities are more versatile and can produce new designs relatively easily. Additive manufacturing equipment, 3D printing and even 3D scanning are also technologies currently in high demand.

- List all resources, machinery available, what raw materials they can take as inputs, and to what extent they are able to produce new designs.
- It is also important to take into account the existing skills of the workforce and what training will be required for repurposing. If the new product lines are similar to the traditional products, the workforce will be more comfortable with transferring their skills and expertise, and will generally be easier to train.
- Training sessions can be effectively provided if employees from original manufacturing companies share their skills and expertise through online tutorials, live meetings or recorded videos.

Collaboration vs. Designing Your Own Product

Depending on the level of complexity of the product and manufacturing capabilities, your company may want to either produce its own design and manufacture it, or collaborate with existing medical companies to manufacture parts they need using their designs. Collaborative pairing of automotive companies with healthcare companies is greatly facilitating the need for ventilators in the United States during the COVID crisis ([Medtronic & Tesla](#) ^[15] , [GE & Ford](#) ^[16]). It may be easier to design items of low complexity such as breathing tubes, test tube kits and masks. However, a high complexity product like a ventilator has many parts and needs the collaboration of many suppliers. The pros and cons of both methods will vary.

Pros of collaborating with medical companies may include receiving:

- Designs of medical grade equipment or parts that are already certified, which avoids the process of designing your own products and getting them certified;
- Expert advice and assistance from their personnel to help you retool and train your workforce;
- Shorter lead times, which means you can help the health care community faster;
- Access to a network of professionals and supplier companies that can support your retooling.

Cons of collaborating with medical companies may include:

- Having to buy the designs and blueprints for a price;
- The responsibility of protecting their patented designs and making sure they do not leak from your company in the future.

Developing New Product Designs

Designing your own product could require assessing your team's experience with designing, engineering and developing a product for the medical industry. It is also crucial to assess your company's ability to rapidly produce and test prototypes to reach a certifiable design. Some platforms like [Javelin Technologies Inc.](#) provide rapid prototyping services to designers and manufacturers ^[17]. For companies that want to help with manufacturing but lack essential tools or manufacturing equipment, Javelin

services can facilitate the production of prototypes that can quickly be sent out for certification. Once certifications are received, it becomes feasible for companies to secure the necessary funding to invest in the required machinery.

Obtaining medical certification for your product could cause a major delay in getting it out the door. However, an advantage is that you would have full ownership of your product. It could also be useful to look into producing products using existing open-source designs.

Applications of this Paper for Industries and Research Groups

While the primary aim of this paper is to provide an immediate framework for SME's to repurpose their manufacturing to support the health care community during the COVID-19 crisis, many of the concepts discussed herein also directly align with new and existing Industry 4.0 research initiatives working towards attaining fully Flexible and Reconfigurable Manufacturing Systems. Initiated in 2011, Industry 4.0 is a technological revolution that leads companies to transform from mass production to mass customization and rapidly respond to changing market demands and customer requirements by building fully agile and automated factories, known as smart factories ^[18]. It is evident that Covid-19 not only requires Industry 4.0 concepts as part of the solution, but is also accelerating its global adoption and implementation ^[19]. A core concept of Industry 4.0 is to design for circular manufacturing, which includes end-of-life product management. Companies mass-producing for the Covid-19 crisis must also begin to strategically plan on management of reuse and recycling of their products at the post-consumer stage. In the province of Quebec, some of the many government Industry 4.0 initiatives include the following (descriptions in French):

- Discover Industry 4.0 initiative: <https://www.manufacturiersinnovants.com/fr/industrie-4-0>
- Invest Quebec initiatives: <https://www.investquebec.com/quebec/fr/salle-de-presse/communiqués/5-4-millions-de-dollars-pour-les-centres-d-expertise-4-0-et-la-creation-de-la-vitrine-Mecfor.html>
- Ministère de l'Économie et de l'Innovation (MEI): Industry 4.0 initiatives can be found at <https://www.economie.gouv.qc.ca/fr/bibliotheques/programmes/aide-financiere/programme-audit-industrie-40/>

In addition, there are several other collaborative programs between academia and SMEs that support the above-mentioned Industry 4.0 initiatives. These include:

- The Intelligent Cyber Value Chain Network (CÉOS Net), a project led by ETS with support from ENC-QOR and Calcul Quebec to lead the Digital Transformation of Manufacturing and develop career opportunities for the future. It is one of the most recent Quebec initiatives calling for academia and industries to work together to pave the way to Industry 4.0 implementation. The CÉOS Net project aims at addressing flexible manufacturing logistics using Industry 4.0 technologies. This project was recently submitted and is pending approval from the Canada Foundation for Innovation: <https://www.innovation.ca>
- Next Generation Manufacturing Canada (NGen) Supercluster (Canada-wide): Individuals and organizations who join the Supercluster can participate in Supercluster projects, find new business opportunities within the Supercluster, and find or supply technology solutions. More information can be found at <https://www.ngen.ca/join>

Quick Links for Industrial Funding and Support during COVID- 19

- Procurement list of supplies needed for COVID-19: <https://buyandsell.gc.ca/calling-all-suppliers-help-canada-combat-covid-19>
- Industries looking to support ventilator production (Canada-wide Program): <https://ocalink.com/>
- PRIMA Call for Solutions for COVID-19: <https://www.prima.ca/en/node/29319>
- Companies seeking government support for retooling: <https://www.canada.ca/en/services/business/maintaingrowimprovebusiness/manufacturers-needed.html>
- CIFAR Artificial Intelligence and COVID-19 Catalyst Grants: <https://www.cifar.ca/action-on-covid19>
- National Research Council of Canada: <https://nrc.canada.ca/en/research-development/research-collaboration/nrc-covid-19-programs>
- Centech: Powered by ETS, Centech is a platform that provides Launch programs and support initiatives for new entrepreneurs to establish their startups. Benefits for startups include mentoring workshops, financial support, access to workspaces and lab equipment. <https://centech.co/en/about-us>

Conclusion and Recommendations

This article aims to provide a preliminary framework for SME's that are aiming to repurpose their business model or production lines to assist with the COVID-19 pandemic. Using the relevant information available at the time of writing, this article attempts to provide guidance on how companies can select the medical products they want to help produce, and what economic and logistical aspects they should consider prior to retooling their factories so that the process is economically viable and feasible for them.

The article also aims to act as a quick resource for programs and funding initiatives by including quick links to websites and programs SME's can apply to within Canada

The COVID-19 pandemic is an unprecedented situation for all nations, and brings in new challenges as the situation evolves. In order to collectively combat these challenges, it is essential that professionals across all fields collaborate and share both their technical and intuitive insights on how to progress towards solutions development for these issues. The authors recognize the importance of this collaboration and welcome any comments and feedback to help keep this document updated and relevant for the manufacturing community throughout the COVID-19 pandemic.

For any comments and suggestions, the authors can be contacted at any of the following:

Aamirah Mohammed
Aamirah.Mohammed-Ashraf@etsmtl.ca

Jean-Pierre Kenné
Jean-Pierre.Kenne@etsmtl.ca

Lucas Hof
Lucas.Hof@etsmtl.ca

Article Links

- [1] Canadian Institutes of Health Research. (2020). Government of Canada invests \$27M in coronavirus research. Retrieved from <https://www.canada.ca/en/institutes-health-research/news/2020/03/government-of-canada-invests-27m-in-coronavirus-research.html>
- [2] Roundup: Tech's role in tracking, testing, treating COVID-19. (2020, April). Retrieved from <https://www.mobihealthnews.com/news/roundup-techs-role-tracking-testing-treating-covid-19>
- [3] Korosec, K. (2020, March). Ford, GM, Tesla given the 'go ahead' to produce ventilators, Trump says. Retrieved from <https://techcrunch.com/2020/03/22/ford-gm-tesla-given-the-go-ahead-to-produce-ventilators-trump-says/>
- [4] Krishnan, R. (2020, March). COVID-19: Parts shortage may pull the plug on ventilator-making. Retrieved from <https://economictimes.indiatimes.com/industry/healthcare/biotech/healthcare/covid-19-parts-shortage-may-pull-the-plug-on-ventilator-making/articleshow/74784732.cms?from=mdr>
- [5] Terlep, S. (2020, March). Distillers Turn Whiskey and Gin Into Hand Sanitizer. Retrieved from <https://www.wsj.com/articles/distillers-turn-whiskey-and-gin-into-hand-sanitizer-11585049650>
- [6] CBC News. (2020, March). Canada Goose making scrubs, patient gowns for hospitals in light of COVID-19 shortages. Retrieved from <https://www.cbc.ca/news/canada/manitoba/canada-goose-scrubs-gowns-covid-19-1.5509623>
- [7] Bashir, N. (2020, March). James Dyson designed a new ventilator in 10 days. He's making 15,000 for the pandemic fight. Retrieved from <https://www.cnn.com/2020/03/26/tech/dyson-ventilators-coronavirus/index.html>
- [8] Thornhill Medical to deliver 500 mobile ventilator systems. (2020, April). Retrieved from <https://www.canadianmanufacturing.com/manufacturing/thornhill-medical-to-deliver-500-mobile-ventilator-systems-250148/>
- [9] Medtronic. Increased Ventilator Production. Retrieved from <https://www.medtronic.com/us-en/about/news/increased-ventilator-manufacture.html>
- [10] McGregor, G. (2020, March). Firms redeploy factories to make coronavirus supplies. Retrieved from <https://fortune.com/2020/03/17/coronavirus-mask-hand-sanitizer-factory/>
- [11] Trieu, R., Kota, P., Turney, D., & Holland, K. (2020, April). 5 Ways Companies Are Pivoting Manufacturing to Help Fight COVID-19. Retrieved from <https://www.autodesk.com/redshift/manufacturing-covid-19/>
- [12] Sherman, E. (2020, February 26). 94% of the Fortune 1000 are seeing coronavirus supply chain disruptions. Retrieved from <https://fortune.com/2020/02/21/fortune-1000-coronavirus-china-supply-chain-impact/>
- [13] Betti, F., Hong, K., Kearney, & World Economic Forum. (2020, February). Coronavirus is disrupting global value chains. Here's how companies can respond. Retrieved from <https://www.weforum.org/agenda/2020/02/how-coronavirus-disrupts-global-value-chains/>
- [14] Koinearth, & Praphul Chandra. (2020, April). 3 ways you can prepare your supply chain for the post-COVID-19 economy. Retrieved from <https://www.weforum.org/agenda/2020/04/supply-chains-leadership-business-economics-trade-coronavirus-covid19/>
- [15] Bloomberg. Musk talks ventilators with Medtronic as it doubles production. (2020, March). Retrieved from <https://www.bloomberg.com/news/articles/2020-03-21/musk-talks-ventilators-with-medtronic-as-it-doubles-production>
- [16] Wayland, M. (2020, March). Ford, GE plan to produce 50,000 ventilators in 100 days. Retrieved from <https://www.cnn.com/2020/03/30/ford-ge-plan-to-produce-50000-ventilators-in-100-days.html>
- [17] Javelin Technologies Inc. <https://www.javelin-tech.com>
- [18] Ferber, S. (n.d.). Industry 4.0: Agility in production? Retrieved from <https://blog.bosch-si.com/industry40/industry-4-0-agility-in-production/>
- [19] Market Intelligence for Printing and Publishing. How COVID-19 is Accelerating Industry 4.0. (n.d.). Retrieved from <http://whattheythink.com/articles/100405-how-covid-19-accelerating-industry-40/>