

MANAGING MANUFACTURING

Through Covid-19

A TP³ Framework

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A TP³ Framework for Recovery

Intro

How should we manage during and after the Covid-19 pandemic? TP³ (Products, Process, People and Technology) is a framework for managing through the pandemic. And building a Smart Lean Eco-system is a way to develop a solution. For the last three years, our team has been working with over 250 manufacturing companies, through a project at the DCMME (Dauch Center for the Management of Manufacturing Enterprises) center at Purdue University. The goal is to create a smart lean manufacturing ecosystem across these firms by leveraging technology to enable competitiveness. Our proposed framework leverages feedback and learning from these interactions.

Manufacturing managers in the US and key participants in the supply chain are faced with how to manage three crucial stages of this crisis, each requiring different rules of operation. Figure 1 shows capacity utilization across the three stages.

The first Stage is to **manage productive operations during the pandemic**. This applies to 'essential' businesses that are permitted to operate, and will have real concerns about virus transmission between employees.

The second Stage is to **manage during a shutdown of operations**, while the pandemic-related 'shelter-in-place' rules are in effect. The third Stage is a **restart of operations**, when the pandemic-related rules are relaxed; the situation moves a little closer to a new normal.

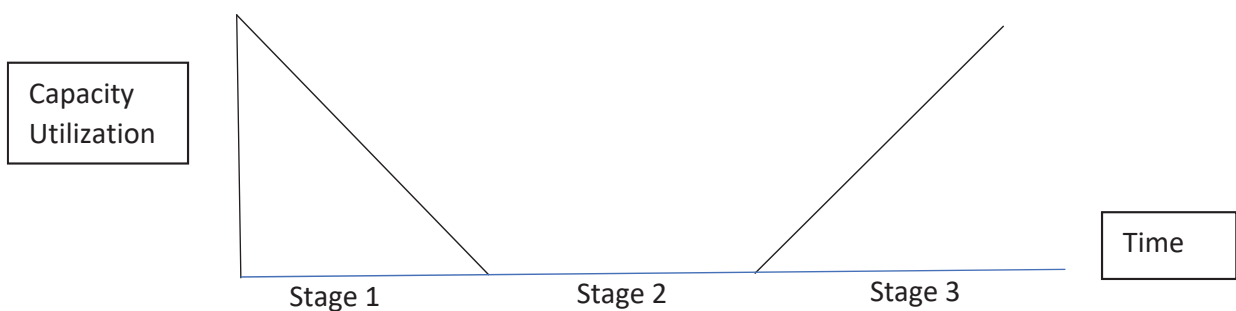


Figure 1: Capacity across the stages



At the close of these three stages, should we not take the opportunity to emerge stronger and more competitive? How can managers build a team focused on emerging more competitive than before the pandemic? We suggest that a focus on creating a **Smart Lean Ecosystem** can help guide the actions that will ensure enhanced competitiveness. Management, operation-decisions and practices, described below, will impact all levels of the

workforce: a) senior management, b) middle management, including supervisors and, c) line employees. Let's start with the three 'P's and how they might change across the stages. Figure 2 provides a summary of the decision framework we recommend which are described in the following sections.

	PEOPLE	PROCESS	PRODUCT
STAGE 1	Communicate	Infection Control	Ramp Down, Supply Chain Effects
STAGE 2	Furlough/Paid Employees	Remote Training	Inventory, Technology roles
STAGE 3	Ramp Up & the New Normal	Adjustments in Infection Control	Ramp Up Capacity, Product Variety

Figure 2: Three stages and associated actions

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Managing Triggers for Stages:

Should operations be kept open during the pandemic, shut down or ramp up? This is a key decision for senior management and primarily focuses on the **“Product”** capacity. A surge in orders and wanting to stay a reliable supplier of components or finished products, would be clear reasons to continue remaining at Stage 1 (and manage the health threat). During Stage 1, it is important to prioritize customer needs and supply reliability. Stage 1’s duration triggers are different from business to business; it may be the case that some suppliers can shut down well in advance, while others remain operational. We surveyed several job shops and distributors and found that a choice to keep operations open were driven by their customer needs and worries about failing to maintain their role in the supply chain. They worried that premature shutdown, which could leave their customers in the lurch, would have adverse consequences for the long-term business survival.

A decision to move to Stage 2 may be forced by employee-absences due to pandemic-related symptoms and needs to quarantine (up to 14 days). Since companies often request employees to focus on minimizing spread, it is reasonable to expect significant variability in production capacity from day to day. Absences may significantly impact production rates and make continued operation uneconomic. Some survey respondents claim that a defined

MANAGING THROUGH THE PANDEMIC, COMPANY A:

Employing 26 people, this successful company does metal fabrications for an automotive OEM and other tier #1 and tier #2 companies. The company also has a consumable supply revenue stream selling cleaning solutions to the same market. In stage #1 the metal fabrications business was shut down for two weeks and all staff furloughed. The cleaning supplies business was maintained. The temporary closure of the fabs business was the trigger for stage #2.

In stage #2, the CEO sourced sanitizer in volume and added this line to the consumable supplies range. The CEO also sourced a surface-cleaner that leaves a virucidal film. It reportedly is active for many days on solid surfaces including metals. Both these products satisfy the urgent needs of his

MANAGING THROUGH THE PANDEMIC, COMPANY A CONT'D:

existing customers so, he rapidly increased sales value, while planning stage #3. Stage #3 is a reduced start-up of the fabs business, timed to begin one week in advance before their largest customer commences production again.

The lesson here, is that during crisis, both agility and flexibility are needed to keep cash-flow through the business. Without cash-flow, a business will succumb to the pandemic.

shutdown, with both associated furloughs and a commitment to rehire, may help them retain employees and conserve cash, while protecting employee health. Carefully-managed shutdowns also allow the build-up of inventory to satisfy customers, at least in the short-term. In Stage 2, should we place employees on furlough or pay them? If paid while in Stage 2, employees can be asked to acquire specified new skills, using remote learning; this would help support an objective to be more competitive at Stage 3 when we start operations once more.

Stage 3 requires the business to be ready for increased product competition and very likely, greater business agility. It may require new products to be offered, greater reliance on technology and redesigns (including possible new processes) to save costs. It may also mean managing the system while rules of management are being rewritten in real-time, based on shifting factors including new virus infections. Infection control may remain a key component of management attention during this period, as we try to get maximal productive outputs where there are real challenges and restrictions due to infection threats. How quickly to ramp up remains an important decision which is going to be multifactorial and unique for every business.

Management of Communications and Transparency

How should information be disseminated during the three Stages? Management of **"People"** demands careful communications planning; the nature of those communications vary by Stage. A key reason to manage across all Stages is that the ability to ensure you get your best staff to return; achievement of this will in part be directly related to your ability to communicate effectively during

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Stages 1 and 2. Firstly, we need to identify the channels of communication available to reach every employee; these may be several and require perfect managing to keep everyone in the loop: cell phone messages, app-based information repositories and web-based platforms such as Microsoft Teams and Google Hangouts. During Stage 1, while maintaining social distance, we need to reassure our staff. Messages should ensure they feel confident, not uncertain; specifically, address paid sick leave during quarantine and the policies that will protect both employee and their family from cross-infection, including the restriction of public access to the work areas, PPE and sanitization. Moving all communications to an app enables information to be posted for asynchronous meal-breaks, avoiding the posting of documents on factory pillars – a common sight in many factories. Before staff worry that management will be moving to reduced operations or temporary closure, management needs to have communications that are ahead of their concerns. Concerns can quickly become a tidal-wave of negativity, so act sooner rather than later. Their worries will include corporate policy regarding lay-offs, furloughs, medical coverage and likely time-lines to re-opening.

During Stage 2, the plant is shut and employees work remotely if they are still on the payroll. However, remote work decreases the serendipitous sharing of ideas and collaboration

that happen in physical workspaces. To offset the lack of co-generated ideas caused by separation from work-colleagues, we need to compensate by creating more opportunities to share ideas based upon shared planning and execution checklists. This shared of goals and successes each week (or appropriate interval) will ensure that independent units of the firm remain synchronized with their plans. Many surveyed managers we spoke to, stated that ‘communication’ is their top priority. There are benefits in continuous touch points; they ensure synchronization of efforts across management and the whole supply chain, maintaining trust and destroying doubts. Clarity of the messaging underpins the attainment of trust.

Collaboration meetings often get enhanced with video sharing by all participants, because a lot more is conveyed during meetings than what is said; body language and gestures enhance communication. Video-sharing allows richer content to be seen by all; marked-up documents, shared whiteboards and pictures, enable a richer communication stream. Check out access to bandwidth and be proactive in improving individual’s data-speeds, rather than leaving this to chance. This action alone says, ‘you are important and we want to see and hear what you have to say.’

Stage 2 may also be the time when aims to introduce new technology are developed. There



may be plans to introduce more automated transfer equipment, automated cleaning, cobots and augmented reality-based tools that speed up the move towards digitization. The speed and efficacy of business-recovery and competitiveness during Stage 3 will depend on investment now: factors include team-based planning, the importance of sharing and making sure that staff feel that they are valued and part of the solution, not the problem.

In stage 3, supply-chains have to be primed in order to get back up to speed; component manufacturers at and below tiers 1 and 2, need to have continuous supply in order that the EOMs can produce; to further drive the economic recovery. The pace of ramp up, has to be synchronized with both the demand downstream and available supply upstream. Once again, the quality and timeliness of communications with your supply chain partners will be critical - to the most cost-effective move towards full production. People will also need to be smart in thinking and performing with agility; rapidly adjusting production plans and employee allocation to function will help ensure that the business is fit for purpose in challenging times. None of this will go smoothly or cost-effectively if you have not already secured employee goodwill during Stages 1 and 2. Support the goodwill by having supportive policies and timely, clear communications at all times. Now, at Stage 3, the time spent on communications and transparency will engender a spirit of trust and

MANAGING THROUGH THE PANDEMIC, COMPANY B:

Employing over 3,500 people, this successful, large manufacturing company in Lafayette, Indiana has aggressively implemented several infection-control mitigation activities. Communication with employees is a key, so they have developed a mobile phone app that provides for two-way, real-time communication for employees.

They have mapped the plant workstations to identify the proximity of workers. As a result, they have either separated them by at least 6 feet, or require workers to wear a plastic face shield (fabricated urgently, in-house from clear, plastic sheets). They have implemented comprehensive cleaning and sanitization across the facility.

The lesson here, is at the start of the crisis, both agility and flexibility are needed to not only develop a method to communicate with a large workforce, but also how to quickly implement actions to mitigate the infection-control risks within a large factory.

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purpose and will make your job easier and faster. These same factors will also help you stay ahead of other competitors, who may fail the test.

Managing Operations Within Stages

Infection control, termed here as “I”, will need to be explicitly managed during Stages 1 and 3 of operations. How should managers convert this requirement into a process based view? Value Stream Mapping (VSM) is a first step towards implementing a lean process. We propose **VSMI** (Value Stream Mapping with Infection control), as a methodology to manage operations during Stages 1 and 3. We further propose the infection control layer as implementing rules regarding social distancing between employees, rules regarding surface touch-time between employee contact, appropriate ventilation, staggered arrivals and departures, staggered use of common areas and so on. Thus, **VSMI** is a tool to positively manage and affect ‘**Processes**’ that vary across Stages. Please see the Appendix for an example of a VSM process followed by a VSMI process.

During Stage 1, when the pandemic worries are still in effect, protecting employees at work requires immediate mapping of the internal supply chain, to understand employee-separation and contact-surface interactions. This map will require a close understanding of time and motion associated with manufacturing, including steps that include supplier receipts at the loading dock, multiple workers at

close proximity, required transfer of material between stations, shipping dock handling, and transfer to trucking as examples. This mapping task can best be supported by implementing a lean 5 S, especially the first 3 S’s: **1. Sort** through all materials in each work area and move out everything not needed at each work area, **2. Set in Order** all tools and suppliers that are used in each area based on frequency of use, **3) Shine** all equipment to ensure it is clean and free of contamination.

During Stage 1, distancing can be accomplished by adjusting the number of shifts (to reduce the number of employees in each shift), but likely decreasing production rate. Alternately, if a shift is added, the same production output can be spread across multiple shifts. More shifts, with fewer employees per shift, may reduce infection transmission, but may increase cost of utilities, such as monitoring. This may be an option to keep daily production on track.

It will be important to practice social distancing when conducting daily team meetings – some companies are drawing circles on the floor to show people where to stand. To reduce aggregation of employees during lunch time, consider shifts with staggered starts; reduce queuing at plant entry and workwear change and elsewhere, as necessary. Other changes could include staggered plant shift completions. Where more shifts are introduced, different methods of shift handoff may be necessary including



the possible use of PA broadcasts. Packaging materials may require attention due to the prevailing research on virus-viability duration on different surfaces; whether metal, cardboard or plastic. Increased monitoring of throughput in the packaging area may be needed at first; wait times will have an implication for inventory control and you will want to ensure there are no hold-ups that could affect production while maintaining your inventory policy, FIFO for example.

We already discussed some of the employee decisions we make to manage Stage 2 and their implications. If we could afford to keep employees on the payroll, then their time at home can be used productively and as an investment in the future effectiveness of the business. Their time at home can be used to explore process redesign (including new technology) with virtual collaboration. New collaboration tools enable quick sharing of ideas. We can ship prototypes to employee's homes to enable visualizations, use AR tools to communicate ideas; we can effectively create digital twins of the physical operation by continued, virtual collaboration.

Management of operations during Stage 3 may determine business survival. Yes, we have to efficiently ramp up capacity to match supply chain needs, but now, have to adjust to comply with current guidelines for managing infection control, and track everything too. Key decisions concern synchronization with supplier ramp-ups and customer ramp-ups. A single error may result



in severe demand mismatches. Further decisions may include new policies about flexible sourcing, the possible use of outsourced capacity and expedited shipping options. These considerations may help solve further demand mismatches.

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Managing the New Normal of Pandemic Recovery: building a smart manufacturing eco-system

As the economy picks up and orders flow, for people at work, it may take many months (or years) until things return to how they were. A vaccine may take years, and inoculation programs to cover the globe's 8 billion people will take even longer; cheap, rapid antibody test kits may be a long time in coming. We can take a glass-half-empty view of the future, or glass-half-full. Let's adopt this second strategy to deal with the new Normal.

We recommend building a **Smart Lean Manufacturing eco-system** as a paradigm to a successful recovery from the pandemic. The basic concept is explained in Figure 3, and can be understood as consisting of three stages: i) Before the pandemic, assume that there is a cost of technology that is volume independent, and a cost of labor that is volume dependent, whose intersection point, labeled A, provides a breakeven point. ii) With the pandemic, and associated **VSMI requirements**, the variable cost of labor increases, thus increasing the slope of the labor-cost curve, and decreasing the breakeven point to a lower breakeven, volume B. iii) As technology is more widely deployed, the cost of the technology decreases; either because of new market entrants

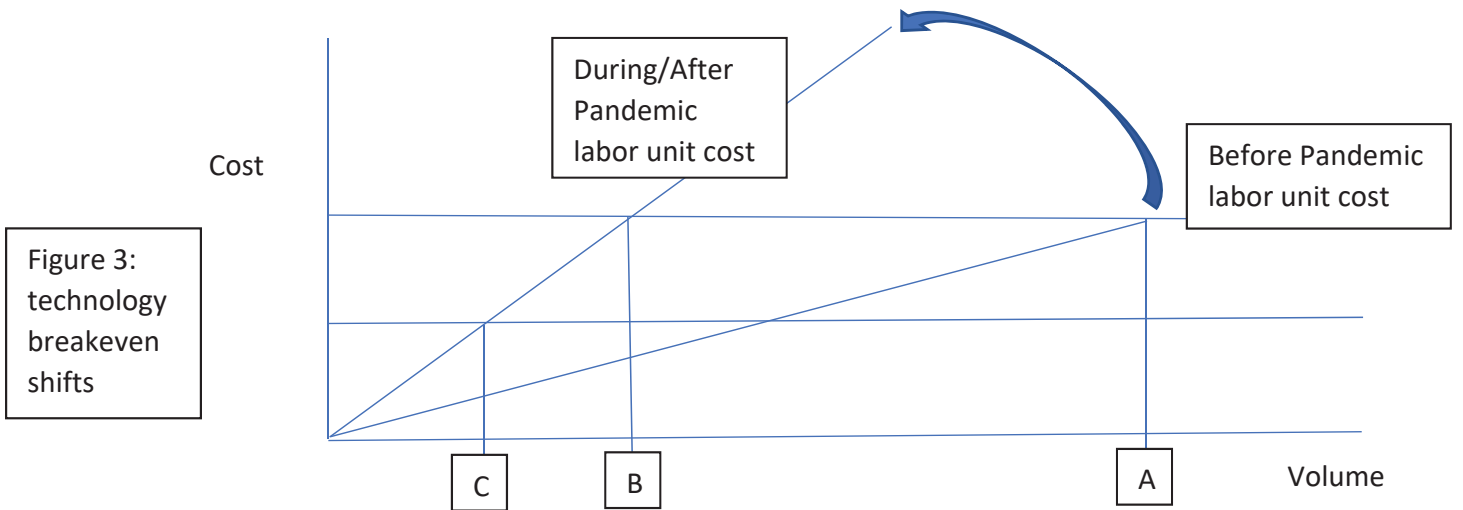
(competition) or sales-volume cost-reductions; thus the breakeven point decreases even further, to a breakeven volume of C.

Figure 3 suggests that **Technology**, which is scale independent, may be justified as a tool to remain competitive, due to the lower, associated breakeven volumes. It suggests technology viability even for small-volume manufacturers managing through the pandemic. Relevant technology includes cleaning robots, assistive robots to check inventory counts, drones to count inventory status and sensors to track work progress. Cobots that enable enhanced performance by individuals (without the need for people to work in close proximity), could enable productivity to be improved and thus be justified on an **RoI** basis. These tools enable employees to be more efficient while maintaining **VSMI** process layouts.

Another use of technology would be a sensor-based smart system can also enable automated tracking of behavioral conformance. An application firm is one with large numbers of personnel, such as distribution centers or processing plants. These smart eco-systems can then be connected across a supply chain to ensure a safe chain of custody for items. Such systems can ensure that the health of employees involved in the supply chain is protected, and adherence to safety rules ensured.



¹Value is not all about take-home pay. People want acknowledgement, an appropriate level of autonomy and flexibility that suits the individual, a clean, safe and well-lit environment and relationships that are adult, respectful and trusted.

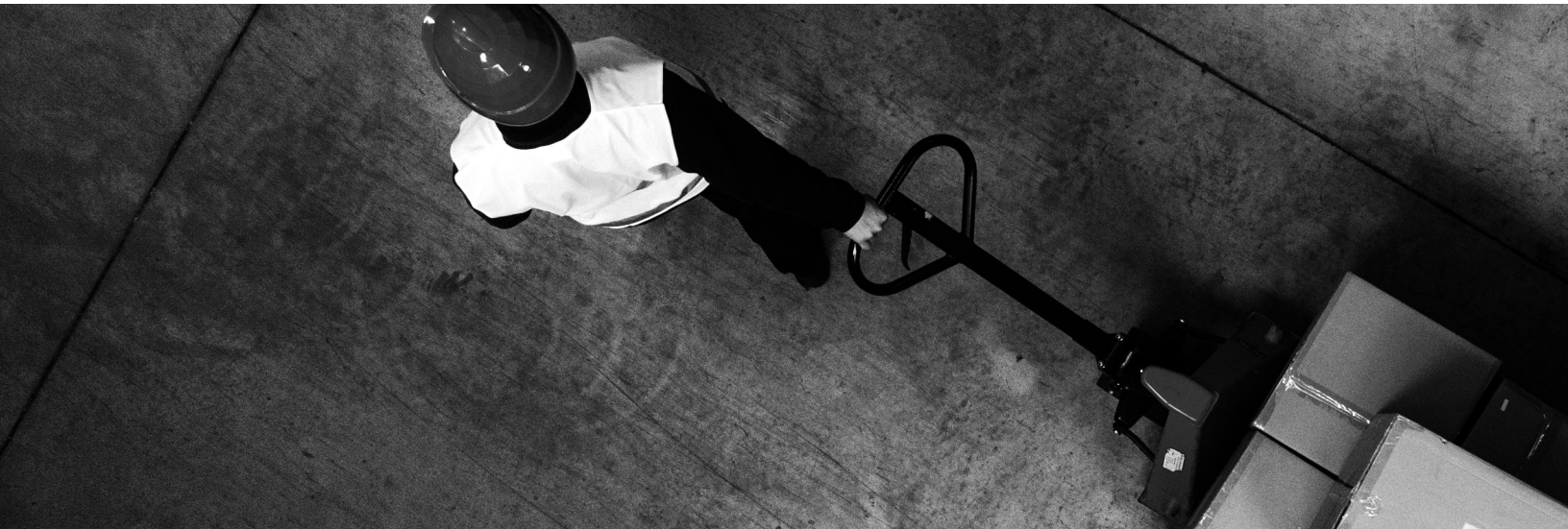


A significant change for many businesses will be to value their **People** more appropriately¹. When the front-line workforce gets worried, there are commercial impacts. We see examples at Amazon and Instacart where staff went on strike because their companies were perceived as negligent in the care of staff safety (or that of their families). Many managers are working from home during the pandemic, leaving supervisors and operatives on the front-line. We have to make investments to heal and improve employee relationships, to make real gestures (and communicate these); to show that we value and care for employees and about their families. Communication, that front-line employees are the “heroes” of this pandemic, may be key message.

One thing we will all have learned from our pandemic experience, is how essential it is to have

multi-tasking employees that can cover for others (and maintain total productive effectiveness) when people are missing. When we certificate staff to do a task, they may be categorized on BOTH skill sets AND behavioral norms. Why both? Many companies around the world use both skills/performance AND behavioral norms. They know that work safety, work quality and staff-retention start with a healthy work-culture. Work-culture depends on behaviors, not outputs. Healthy work-culture does not happen automatically. Management should agree behavioral norms, refer to them in contracts of employment, Personal Development Reviews, Pay and Reward schemes, career-promotions and in notices and then people will get the message; it is not just what we do, but how we do it that matters to productivity.

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Some customers may be looking for dual supply to manage risk. On the bright side, many OEMs will now be looking to switch overseas-sourced components and now look for home-produced sources to hedge future pandemics and other disasters. Price, quality, communication, safety-records, 5S, corporate certifications will all play in your favor if you leverage these. On the purchasing side, your key components will need to be dual-sourced and ideally where supplier-capacity can be ramped up as required. This suggests the need to carefully plan **products** offered, to satisfy supply chain demands.

Change should be the new normal. That cannot just be driven from the top; it needs all staff to get used to productive change and to feel that they own that change. To achieve that, staff at all levels need to participate in decision-making and be involved in the **process**. When people own the process of change, they feel responsible; with so many eyes looking out for issues (and not just at their own work-space), there are fewer failures and down-time incidents. Involvement in successful change will change the work-culture to one where productive change is the new normal. This agile mindset for change will help the whole business keep ahead of the competition.





Summary

A TP³ approach i.e., a focus on **People**, **Process** and **Products**, leveraged with Technology provides an approach to manage across three stages during a pandemic, i.e., the ramp-down, closure and ramp-up of capacity utilization of a facility. Agile deployment of the three **P's** across the three stages, and a plan that anticipates recovery, may provide a clear message for people across the organization. **VSMI** is here to stay, albeit with different manifestations across the stages. The new normal will offer opportunities to compete based on agility, with winning businesses able to adapt to service demands across the supply chain.

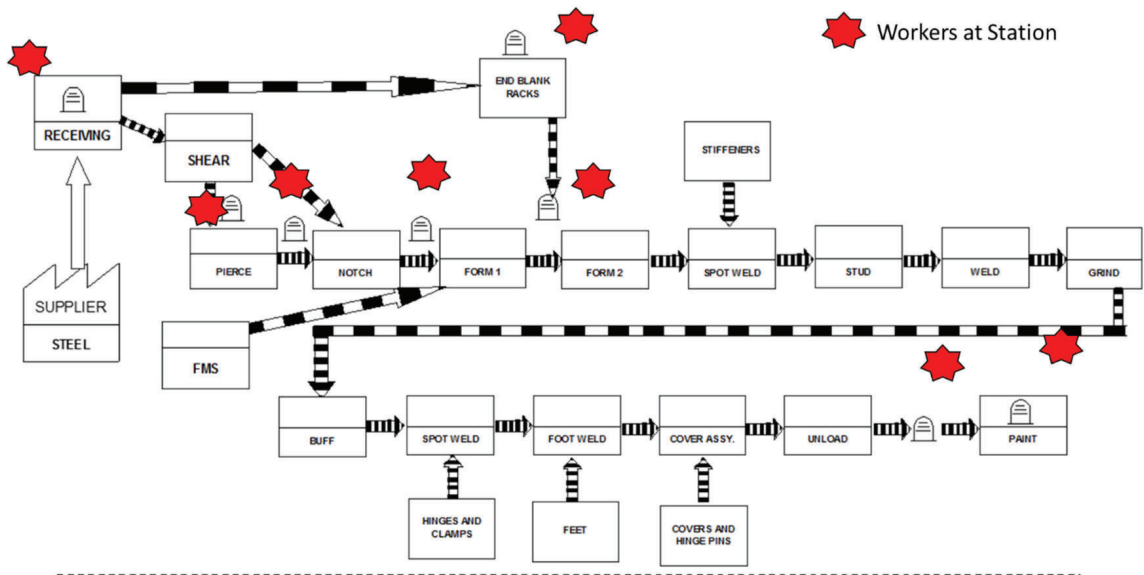


Appendix 1: VSMI

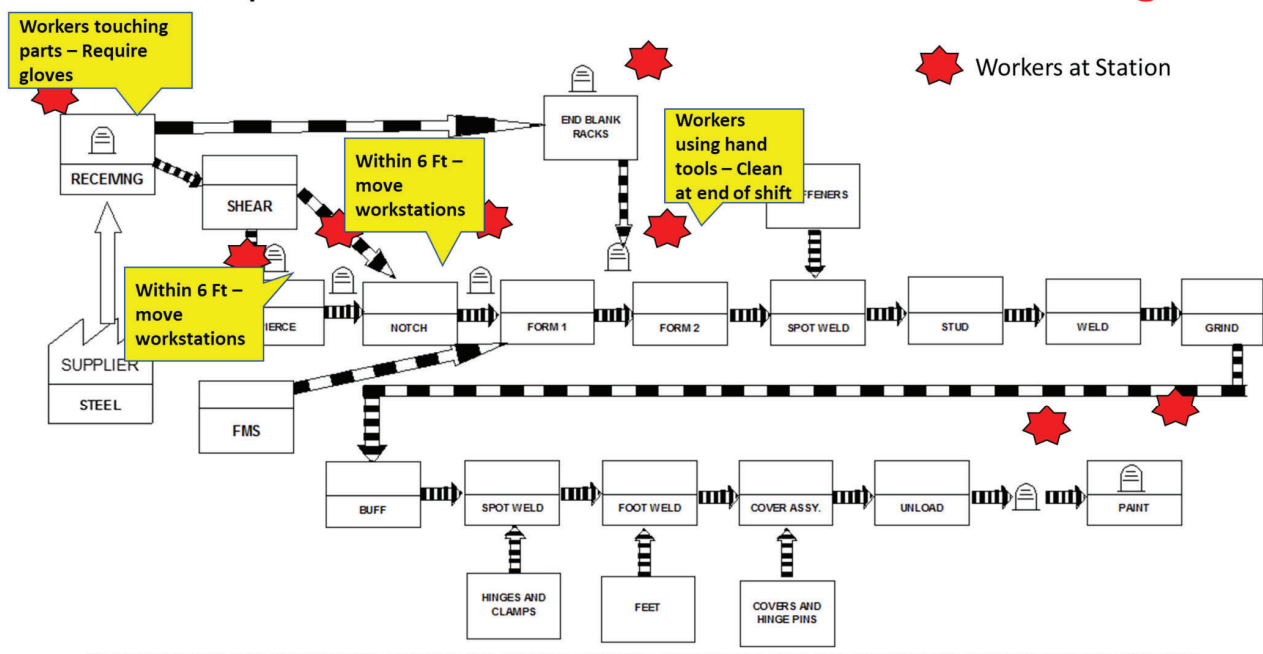
VSMI

VSMI is a new term that adds Infection control to the lean methodology of Value Stream Mapping (VSM). Below is an example of the material process flow through a manufacturing plant with the points of risk highlighted with a star. The second figure is the same flow with risk mitigation actions noted, for specific workstations.

Example: Material Flow: Process Level – Points of Risk



Example: Material Flow: Process Level – Risk Mitigation



Appendix 2: Checklists

INFECTION CONTROL CHECKLIST

- o **Advise** employees to stay home if sick. This may require a relaxation of sick time-off policy
- o **Clean** and disinfect common areas including restrooms as well as work areas, especially between shifts
- o **Restrict** or limit employee access to non-work areas such as: offices, conference rooms, break areas, cafeterias, etc.

OPERATIONS CHECKLIST

- o **Check** if all employees are separated by over **6 feet** at all steps in the operations, included material handling etc. This may involve identifying paths for each employee to follow, timing of transfers etc.
- o **Monitor** truck drivers' deliveries of supplies and pick-up of shipments. Some companies are preventing truck drivers from entering the facility and using restrooms. Others are requiring truck drivers to leave their truck doors open, with unloading and/or the loading performed by the company dock personnel.
- o **Reduce** aggregation of employees during lunch time, consider shifts with staggered starts to reduce the queuing to enter the plant and change to plant outfits, gather tools etc.



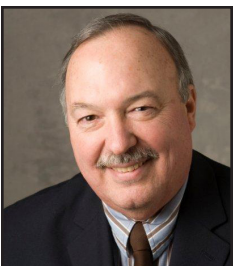
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