



PPE Factbase

April 2020

Typical personal protective equipment (PPE) for healthcare workers falls into four broad categories

Masks



- Two mask categories: respirators and face masks
- Respirators
 - Three product categories: Powered air purifying respirators (PAPR), Air purifying respirators (Gas masks), Face fitting respirators (FFRs)
 - Provide wearers a degree of protection from airborne particulate hazards, whereas “face masks” do not
 - Respirators are rated and regulated in the US by NIOSH,
- Face masks
 - Categorized as either medical grade or non-medical grade, depending on their “liquid barrier protection”

Gowns/coveralls



- Four AAMI¹ “levels” based on sterility and liquid barrier protection
 - Level 1: Minimal risk (e.g. gowns used during basic care)
 - Level 2: Low risk (e.g. gowns used during blood draw, suturing, in ICU, or in a pathology lab)
 - Level 3: Moderate risk (e.g. gowns used during arterial blood draw, insertion of IV lines, in the ER, or for trauma cases)
 - Level 4: High risk (e.g. gowns used during fluid intense procedures, surgery, or when pathogen resistance is required/infectious disease suspected)
- Disposable or reusable
- Style: “Full Coverage” preferred to “Open Back” for COVID-19 crisis

Face Shields



- Used in combination with a mask and goggles to enhance liquid barrier protection
- Critical due to low supply of N95 masks – shields protect the mask from liquid contamination and enable prolonged re-use
- Disposable or reusable
- Low “barrier to entry” for manufacturing

Gloves



- Standard, disposable rubber gloves most commonly used
- Must be powder free per FDA rules, latex free strongly encouraged
- Supply chain heavily concentrated in Malaysia; cannot scale production quickly as gloves is as easily automated

“Masks” are a broad category – the higher the level of protection, the more complex the supply chain



Powered air purifying respirators (PAPR)



Air purifying respirators



Face Fitting Respirators (FFRs) – NIOSH rated



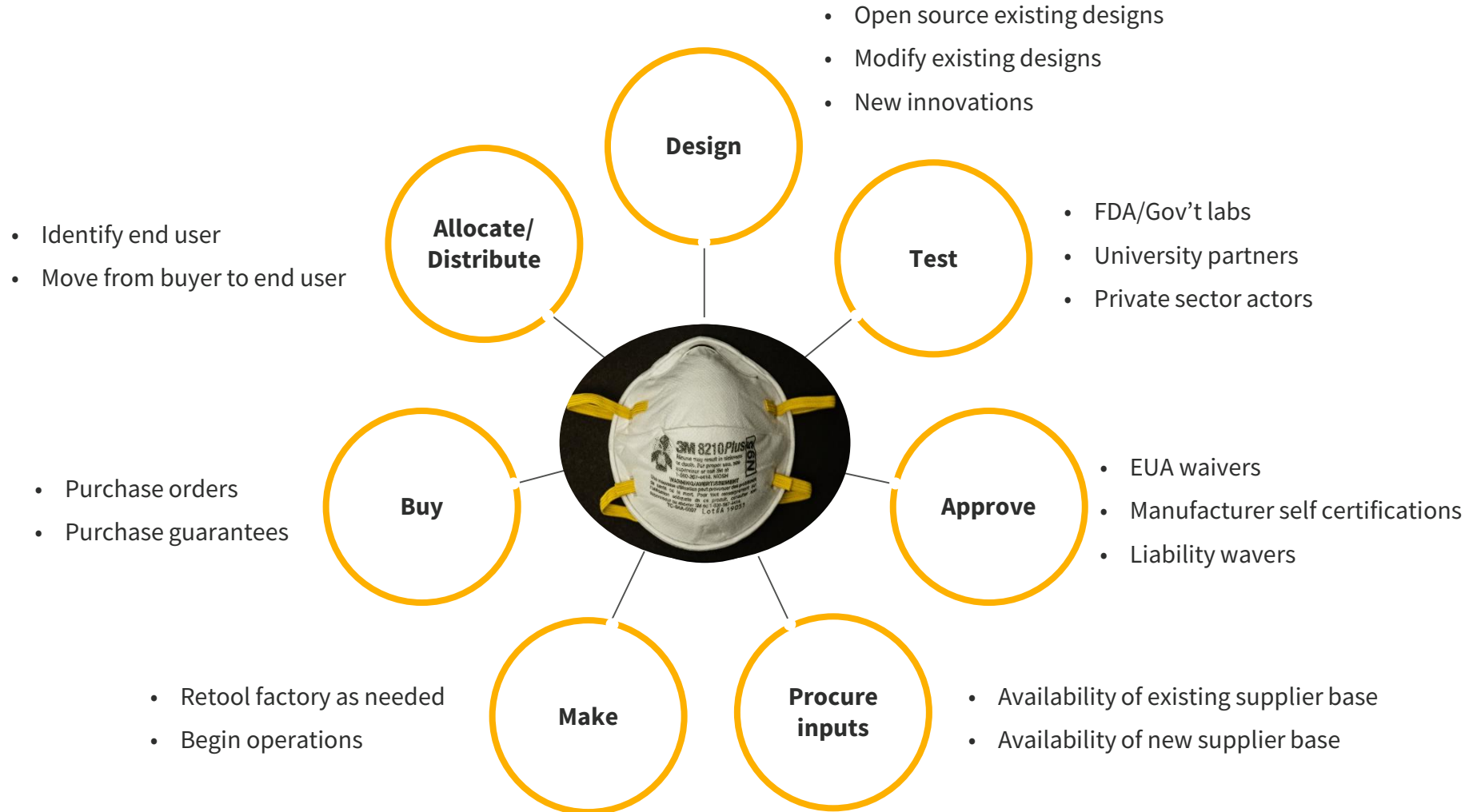
Surgical/ Procedure Masks –ASTM rated



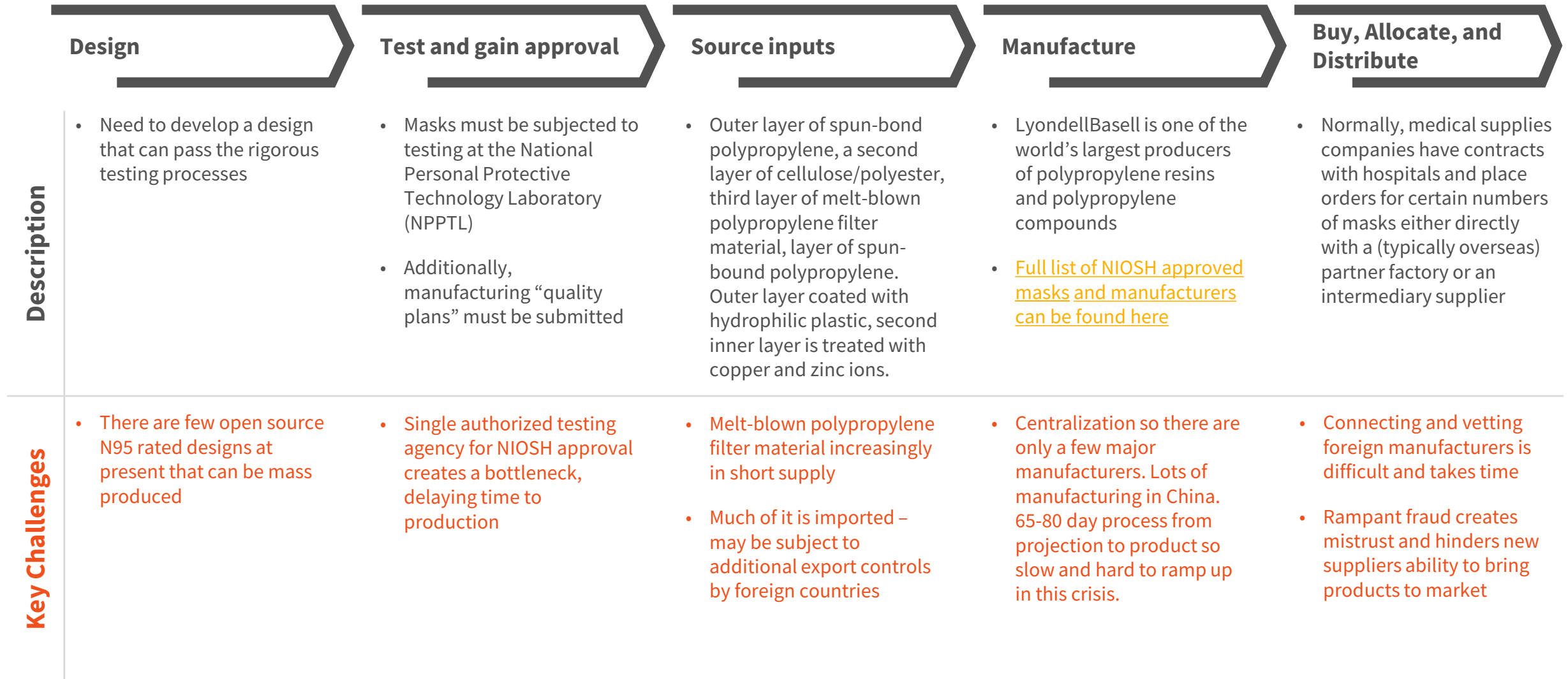
“Non-rated” Face Masks

	Powered air purifying respirators (PAPR)	Air purifying respirators	Face Fitting Respirators (FFRs) – NIOSH rated	Surgical/ Procedure Masks –ASTM rated	“Non-rated” Face Masks
Description	Closed systems that use a motor to push air through a filter and into a “hood”	“Gas Mask” – user powered air purifying respirators	Distinguished by the close fit to face, rated based on particulate level they filter out (EG N95)	Three levels distinguished by level of liquid protection they provide (“spray” testing)	“DIY” masks, no liquid protection or ASTM rating
Example product	3M Versaflo TR-300	Advantage 3200	3M 8210V, N95 Mask	Cardinal Health Surgical Mask	Brooks Brothers Face Mask
Rated particulate filtration	✓	✓	✓	✗	✗
Production complexity	High	High	High	Medium	Low
Price	~\$1,000 per unit	~\$250-\$500 for unit (Replaceable cartridges an additional ~\$25-\$50)	~\$1 under normal circumstances, as high as \$5 with current crisis	\$0.25-\$0.50 per mask (sold in boxes of 20-50)	Free (for DIY), to \$10-\$20 for higher quality, reusable masks

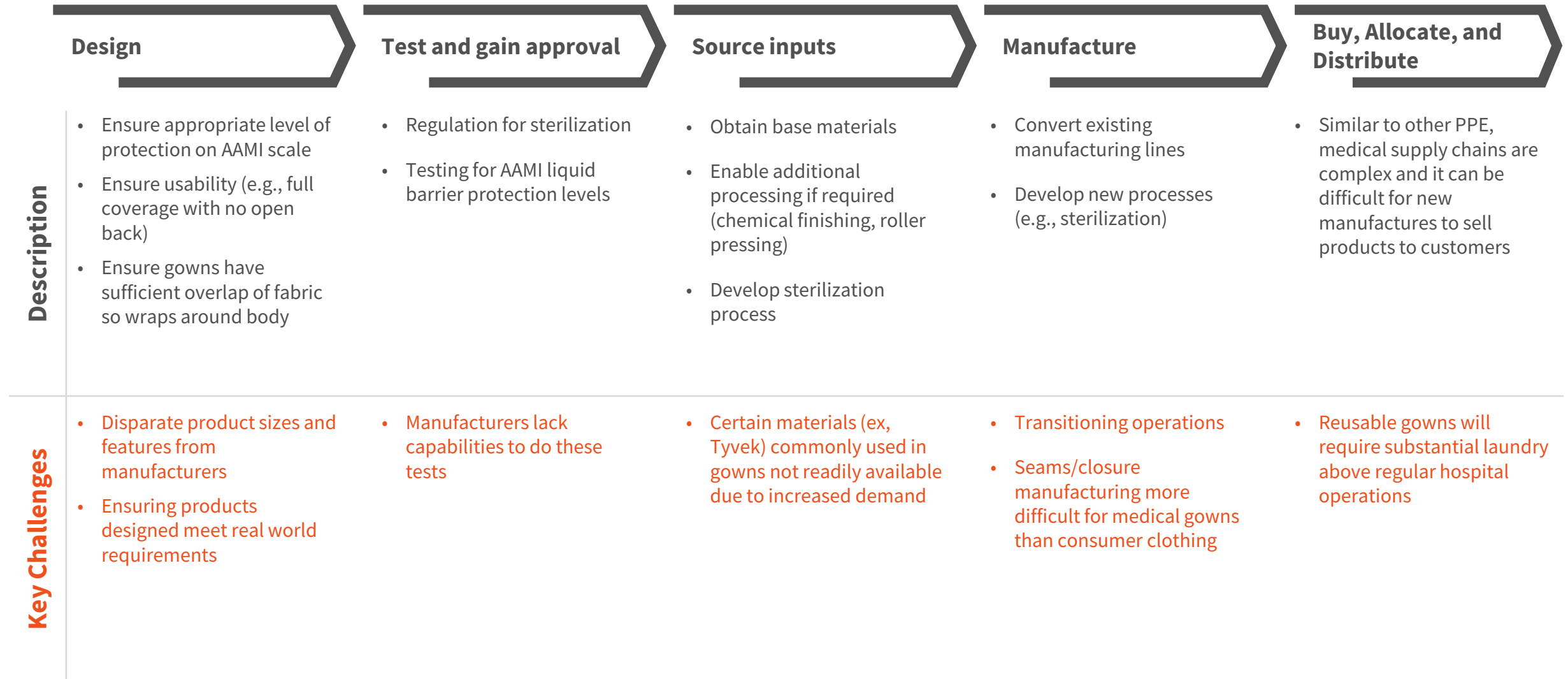
PPE requires “matchmaking” along seven supply chain dimensions



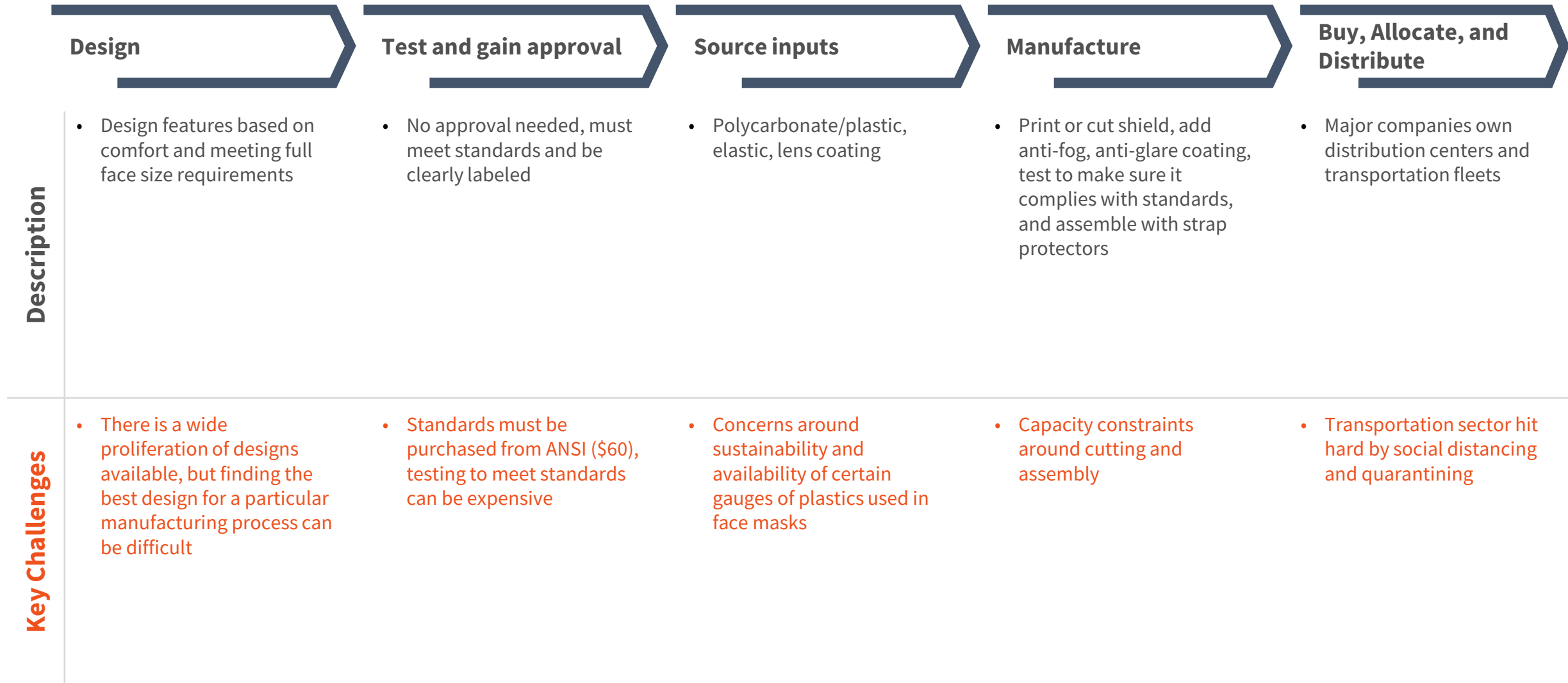
N95 mask value chain



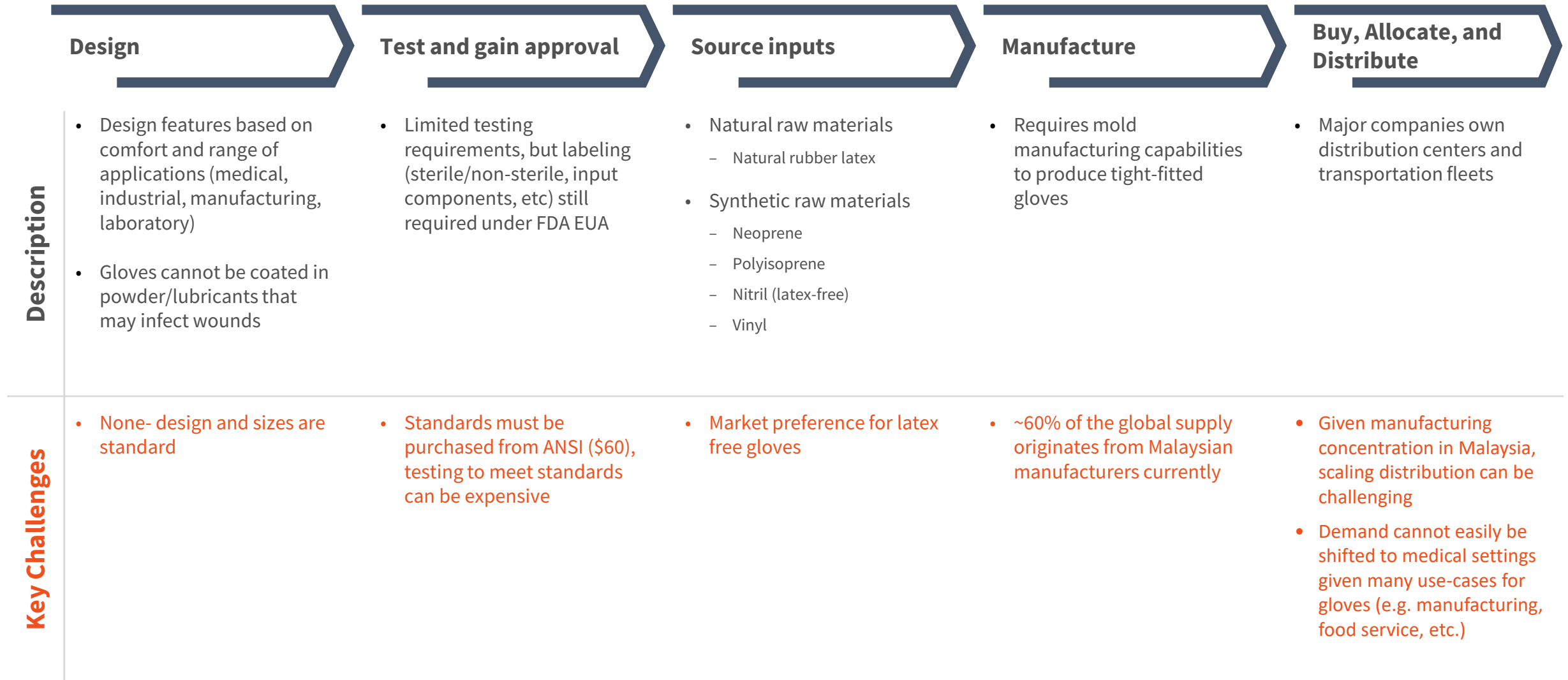
Gown value chain



Face shield value chain



Glove value chain



The CDC lays out clear guidelines for cleaning, disinfection, and sterilization practices to control the spread of pathogens and COVID-19

Cleaning



- **Removal of visible soil** (e.g. organic and inorganic material) from objects and surfaces
- Accomplished manually or mechanically using **water w/ detergents or enzymatic products**

Disinfection



- Process that **eliminates many or pathogenic microorganisms on inanimate objects**
- There are **two main groups of disinfectants** as outlined by the CDC
 - Chemical disinfectants (e.g. alcohol, chlorine, formaldehyde, quaternary ammonium)
 - Miscellaneous inactivating agents (e.g. UV radiation, pasteurization)

Focus of these materials

Sterilization



- Process that **destroys or eliminates all forms of microbial life** and carried out in healthcare facilities by physical or chemical methods
- **Expanded use cases to PPE** as a result of COVID-19 shortages

More effective in killing pathogens, including COVID-19

Disinfectant overview

	Input sourcing	Manufacturing	Application
Description	<ul style="list-style-type: none">• Specific inputs dependent upon disinfectants• Quaternary ammonium compounds (quats) are a popular main active ingredient produced by Lonza, Pilot Chemical, and Stepan• Other raw chemicals include fatty alcohols, ethanol, isopropyl alcohol, and benzyl chloride	<ul style="list-style-type: none">• Germicidal wipes are primarily manufactured by PDI Healthcare and Clorox<ul style="list-style-type: none">– PDI has ~80% market share– Clorox has ~17% market share– Metric Cavaside has ~3 market share• Manufacturers have ramped up production in order to meet increased demand	<ul style="list-style-type: none">• Disinfectants can be applied in two main ways:<ul style="list-style-type: none">– Wipes on surfaces– Aerosol sprays• Hospitals transitioned away from aerosols 12-15 yrs. ago as studies showed they were unsafe for to inhale• Aerosols require long wet contact time (~8-10 seconds) before wiping in order to be effective
Key Challenges	<ul style="list-style-type: none">• Export limits: Raw materials to produce quats come from international suppliers who are not exporting due to the pandemic<ul style="list-style-type: none">– US producers must now find domestic equivalents	<ul style="list-style-type: none">• Increase in usage: Driven by heightened cleaning frequency and product usage in hospitals (e.g. Clorox reported ~500% increase in demand in Q1)• Larger purchasing quantities: Driven by concerns about future product availability• Labor force issues: PDI labor force is unionized; limits company's ability to expand manufacturing	<ul style="list-style-type: none">• Increased demand: Hospitals have turned to aerosol sprays/mixtures, which can be less safe for caregivers and patients

Disinfectant development and manufacturing is governed by EPA laws and regulations

Ultraviolet radiation (UVC) can be a useful technique in disinfecting high-traffic facilities and critical PPE

Disinfecting facilities






- Opportunity to **use UV light to disinfect areas, objects, and facilities** that experience high traffic
- China has **enabled UV light technology** to disinfect public buses, floors in hospitals, and money in banks
- Pittsburgh International Airport is set to **deploy autonomous UV light robots** to disinfect floors, handrails, elevator buttons and other high-touch areas

Disinfecting PPE











- UV light can be used to **destroy pathogens on critical PPE**, such as N95 masks
 - N95 masks can be disinfected using UV lighting up to 5x before needing to be discarded
- While effective, UV light disinfection of PPE must be **thorough and cover all parts of PPE** in order to sanitize the entire equipment
- Hospital networks including the **University of Virginia** and the **Atlantic Health System Network** are implementing such UV light technologies to lessen the impact of PPE shortages on frontline healthcare workers

As states begin re-open, industry leaders must be prepared to deploy disinfection plans in order to mitigate the spread of COVID-19

-  Appropriate for use
-  Appropriate for use depending on efficacy
-  Not appropriate for use

Disinfectant use cases for re-opening by type

	When to use	Vendors	Public spaces (e.g. schools, businesses)	Hospitals	Rationale for rating
EPA-approved disinfectant wipes (EPA's List N)	Frequently touched, hard and non-porous objects	PDI, Clorox, Lysol, Proctor & Gamble, Lonza, Kimberly Clark			If supply is stable, EPA-approved disinfectant wipes are most effective in killing the COVID-19 virus
Aerosol disinfectants	Frequently touched, hard and non-porous objects	PDI, Clorox, Lysol, Proctor & Gamble, Lonza, Kimberly Clark			Safe to use on surfaces/objects from a safe distance
UV light	Frequently touched/visited spaces	UVDI, Oxytech Systems, Tru-D			Safe to use given appropriate vetting of UV device/technology
Soap and water	Often in public spaces for cleaning	N/a			While not the most highly effective, soap and water can provide minimal protection