

BORGWARNER

# LPPD Culture Within BorgWarner

LPPDE Virtual Conference

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# Company Overview



# BorgWarner In Numbers

~38k  
Employees

\$15.8  
Billion in  
2022 Sales

80  
Locations

19  
Countries



# Strategic Global Operations

27

Locations in  
the Americas

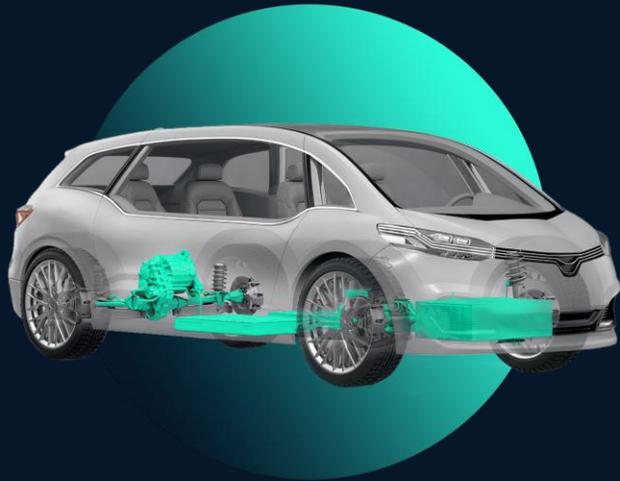
23

Locations  
in Europe

30

Locations  
in Asia

# Electric Vehicle Technology\*



Our growing product portfolio covers virtually all electric propulsion areas including electric motors, power transmission, power electronics, and thermal management.



Battery Systems



Chargers



Controllers



EV Transmissions



Electric Drive Motors



Electric Drive Modules



Power Electronics



Thermal Management

# Foundational Technology\*



Delivering clean, fast-to-market technology solutions to increase efficiency and performance of modern combustion and hybrid vehicles.



AWD + Cross Axle Systems



Boosting Technologies



Electric Boosting Technologies



Engine Timing Systems



Ignition Technologies



Intake and Exhaust Gas Management



P1 Hybrid Architecture



P2 Hybrid Architecture



P4 Hybrid Architecture



Transmission Technologies



Valvetrain Systems

# Commercial Vehicle Technology



Low fuel consumption and a long service life are priorities for commercial vehicles. We offer highly efficient combustion, hybrid and electric technologies for a wide range of commercial vehicles.



Battery Systems



Boosting Technologies



Chargers



Controllers



Electric Drive Modules



Electric Drive Motors



Engine Timing Systems



Intake and Exhaust Gas Management

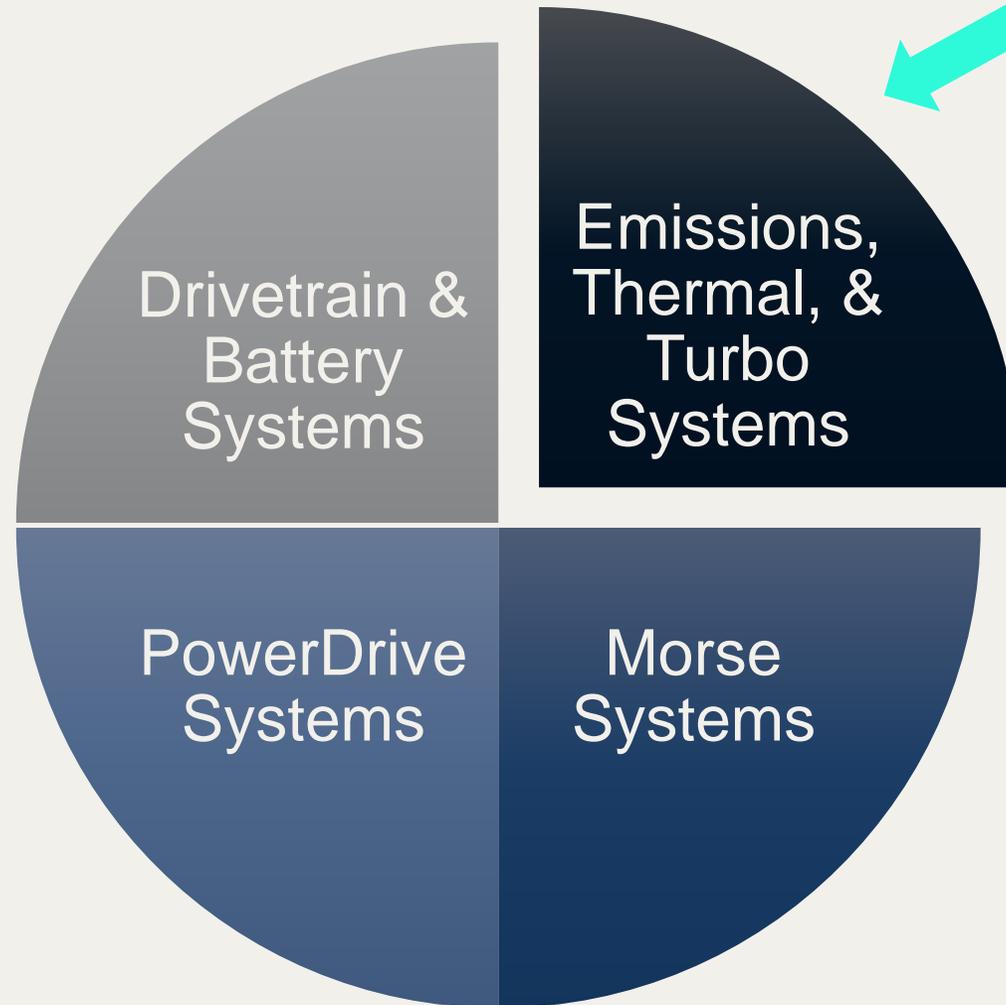


Power Electronics



Thermal Management

# Business Units of BorgWarner



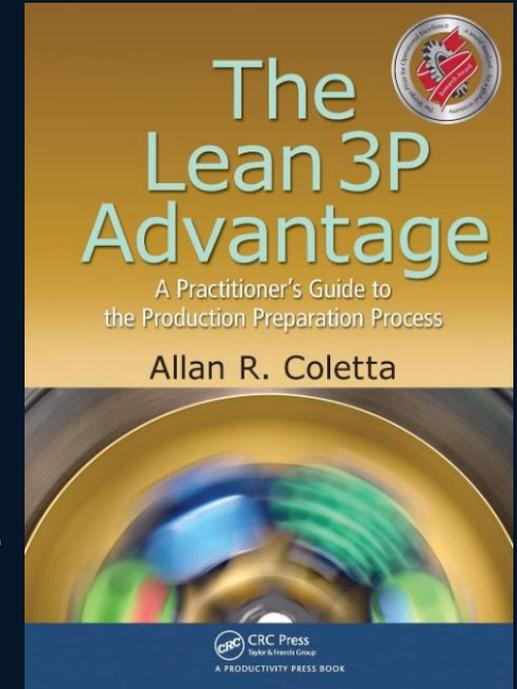
The remaining slides apply to the Emissions, Thermal, & Turbo Systems (ETTS) business unit.

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# LPPD History at BorgWarner

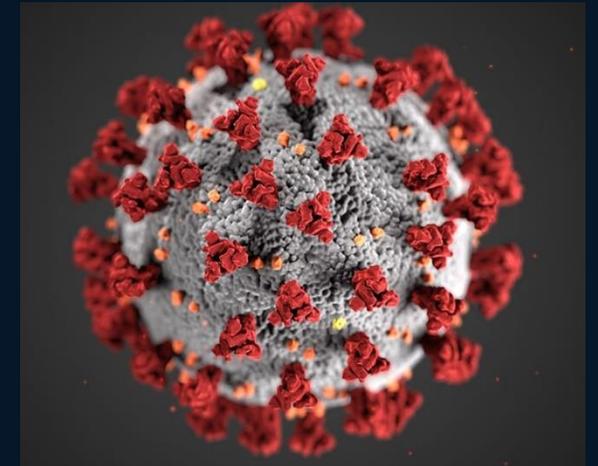
# LPPD History at BorgWarner

- LPPD started out as “3P” workshops, based on Allan Coletta’s book, The Lean 3P Advantage: A Practitioner’s Guide to the Production Preparation Process.
- Certain programs were selected to run these workshops.
  - The programs that were selected were the ones that had issues or needed extra brainstorming power to overcome hurdles.
  - During this trial phase, there was no consistency on which programs needed workshops.
- As traction was gained, more program teams requested workshops



# LPPD History at BorgWarner

- When COVID-19 hit, a virtual method was developed to continue running workshops through the pandemic.
  - Through Microsoft Teams calls, standard spreadsheet templates, and presentations, we were able to capture ideas and cost avoidance opportunities from our home offices!
  - Additional programs were requested to have workshops during this time period.
  - Passionate volunteers offered to facilitate workshops, as no official team was established yet.
  - The ETTS leadership team started noticing the progress that was being made.



# LPPD History at BorgWarner

- In Q3 of 2021, the ETTS leadership team decided to require LPPD workshops for new programs that either required new product technology or new manufacturing processes.
- Due to the increased demand of workshops, an official LPPD group was created to facilitate the workshops.
- The LPPD group is now up to 3 full time global facilitators, 2 interns, and 1 supervisor.
- This group is also supported by local facilitators at each plant.

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# LPPD Process

# LPPD True North

## OUR VISION



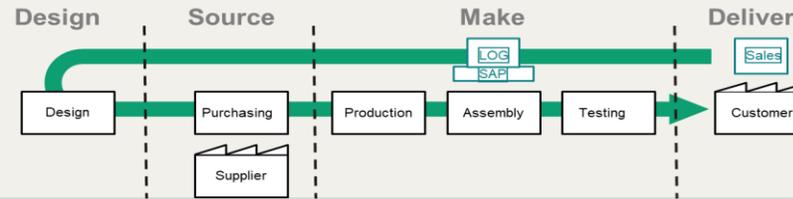
Optimize our Products & Processes by collaborating early in the PDP to increase competitiveness in Quality, Timing & Cost.

## OUR APPROACH



## COLLABORATION

Lean and Agile Product/Production Systems



**ETTS  
Success**

Continuous Improvement  
Leadership and Mindset

## OUR PRINCIPLES



Customer Orientated	Quality Excellence	Failure Prevention	Process Orientation
Flexibility	Continuous Improvement	Standardization	Risk Mitigation
Broad and Deep Expertise	Business Orientation	Collaboration	Quality

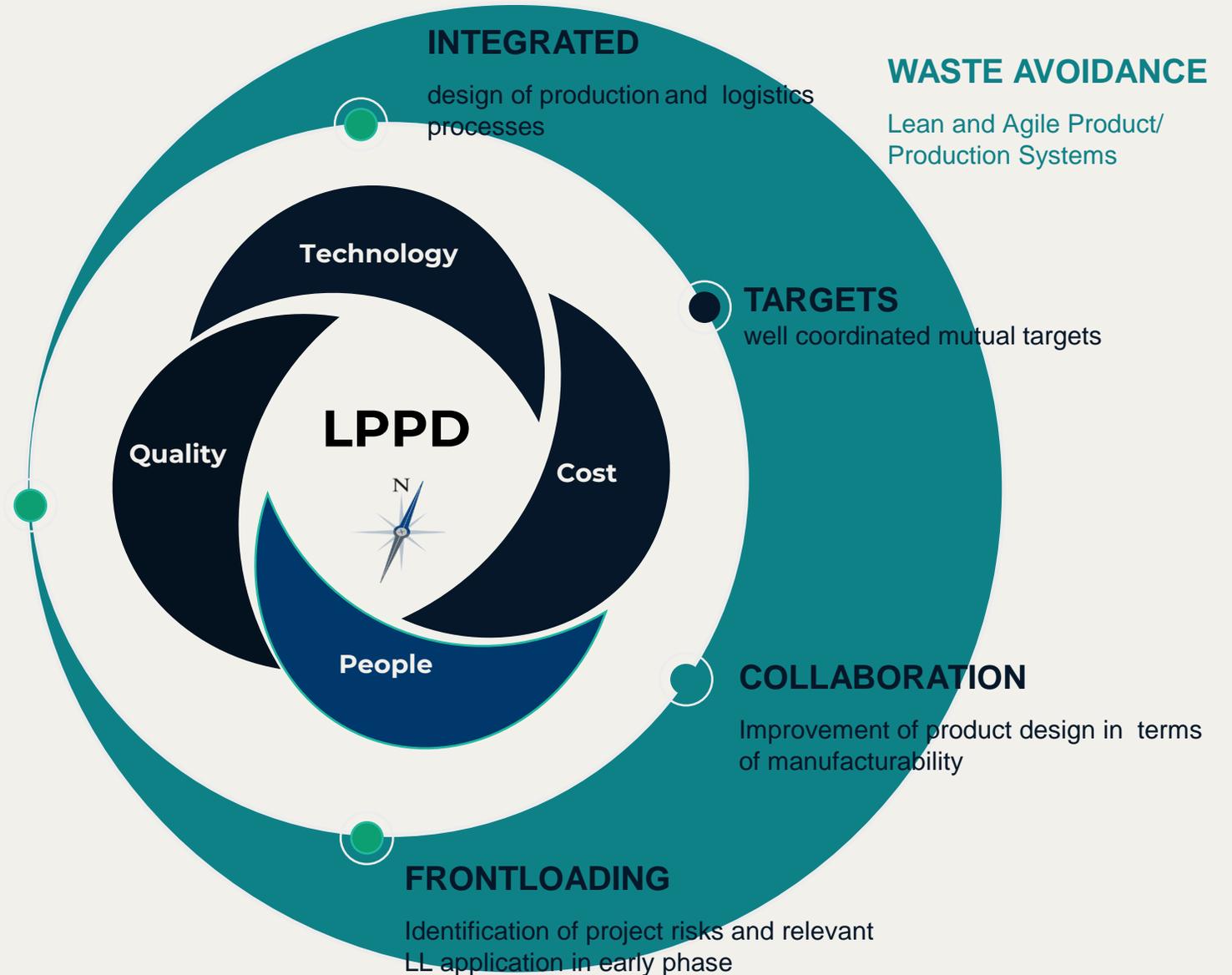
## Essentials

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# What is LPPD?



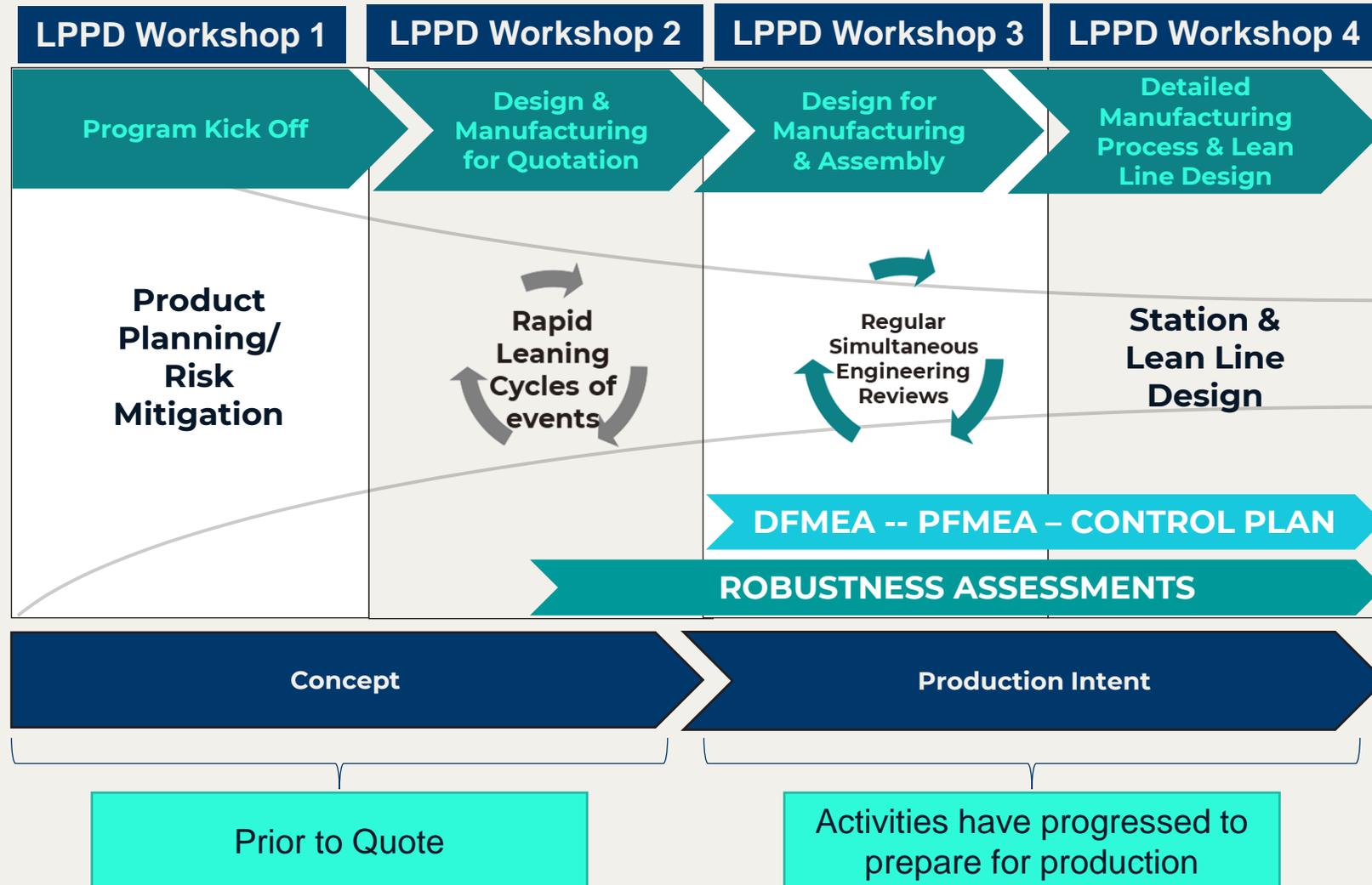
**EARLY INVOLVEMENT**  
of all program relevant functions



# LPPD Workshops

- The LPPD process consists of ~4 workshops.
- The typical workshop length is 3 days.
- The goal of the workshops is to encourage a culture of collaboration with the program's cross functional team.
- To avoid working in silos, the LPPD process requires the project's cross functional team to meet face to face in order to discuss risks, specifications, timing, product design, manufacturing process, and lessons learned from past projects.

# LPPD Funnel



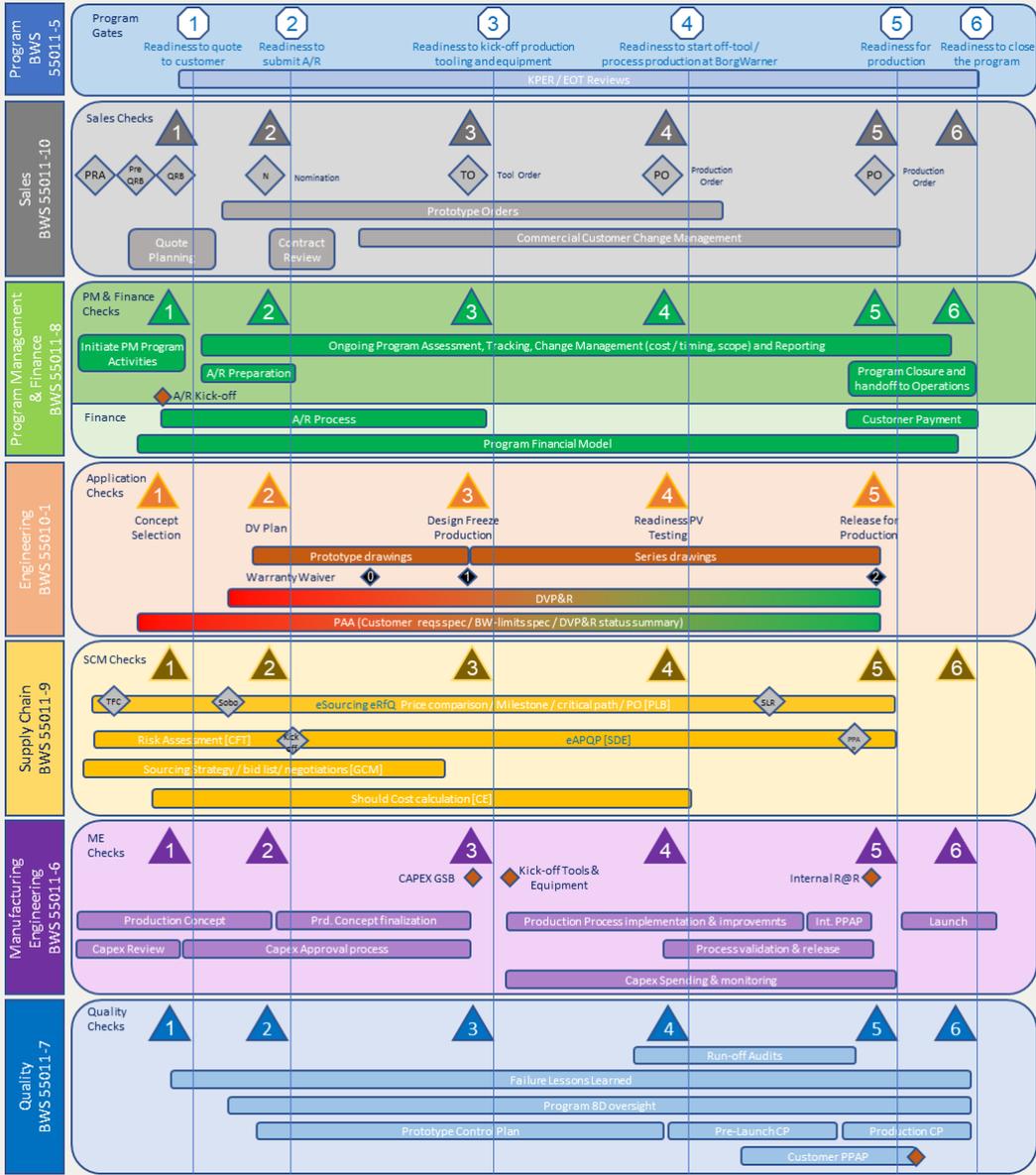
# LPPD Key Participants

Workshop / Function	LPPD 1 PKO	LPPD 2 Design & Manufacturing for Quotation	LPPD 3 DFMA	LPPD 4 Detailed Manufacturing Process and Lean Line Design
<b>Facilitator</b>				
LPPD Facilitator	M	M	M	M
<b>Program Management</b>				
Global Program Manager (if applicable)	M	M	M	M
Program Manager	M	M	M	M
<b>Engineering &amp; Application</b>				
Engineering (R&D)	M	M	M	O
Application Engineer	M	M	M	O
Designer	O	M	M	O
<b>Supply Chain</b>				
Commodity Buyer	O	M	M	O
Program Launch Buyer	M	M	M	O
Supplier Development Engineer	M	M	M	O
Cost Engineering	O	M	M	O
CapEx Commodity Manager	O	M	O	M
<b>Quality</b>				
Advanced Quality Engineer	M	M	M	M
<b>Manufacturing</b>				
Local Manufacturing Engineering	M	M	M	M
Global Manufacturing Engineering	M	M	M	
Product Leader	M	M	M	M
<b>Logistics</b>				
Logistics Coordinator	O	O	O	M
<b>Production</b>				
Operations Management	O	M	M	M
Continuous Improvement	O	M	O	M
Finance & Sales	O	O	O	O
<b>External</b>				
Component Supplier	N/A	O	O	O
Equipment Supplier	N/A	O	O	M
Tooling/Gages/ Specialty Equipment	N/A	O	O	O
External Experts/Outsiders	N/A	O	O	O

# LPPD Process

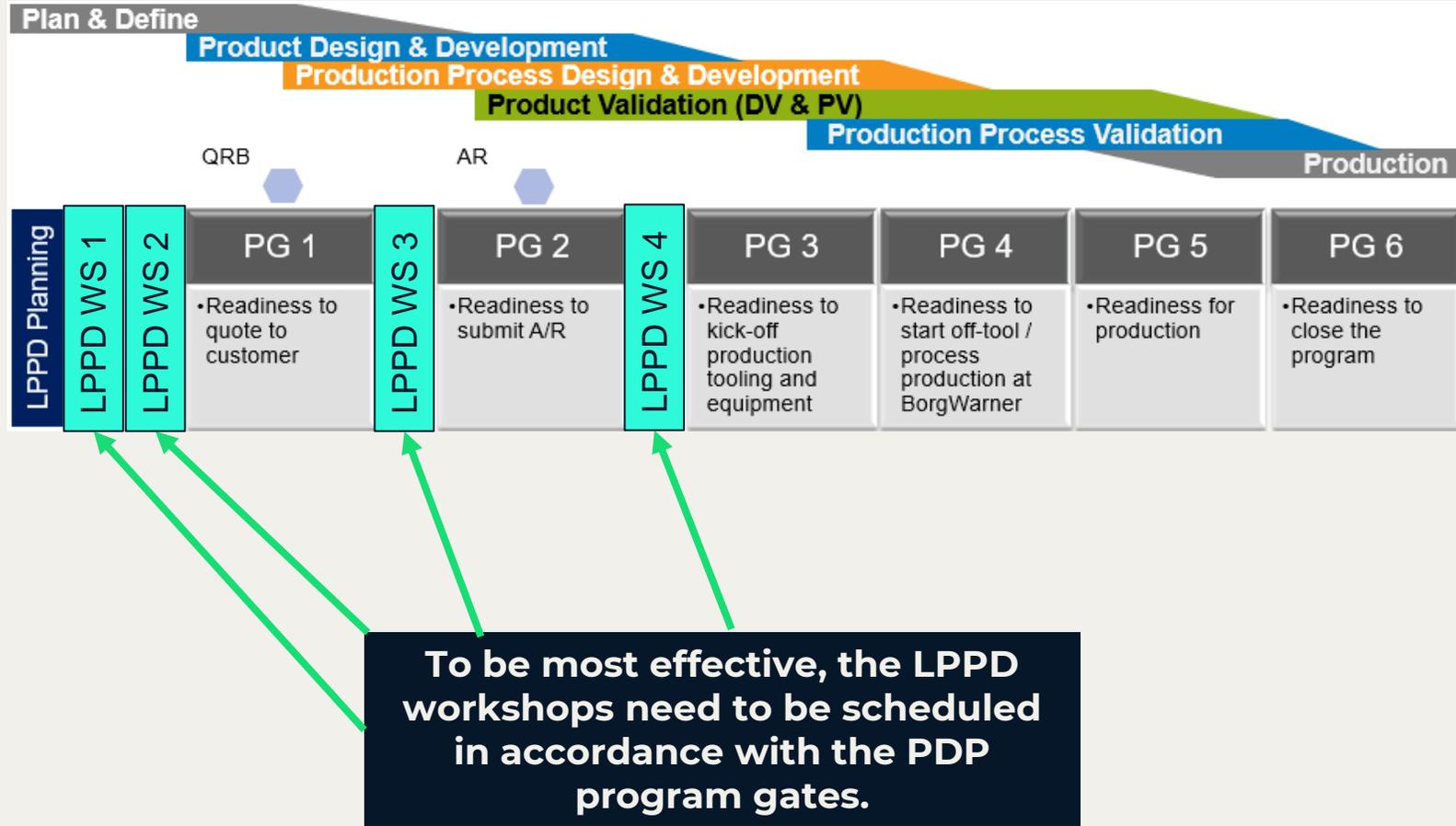
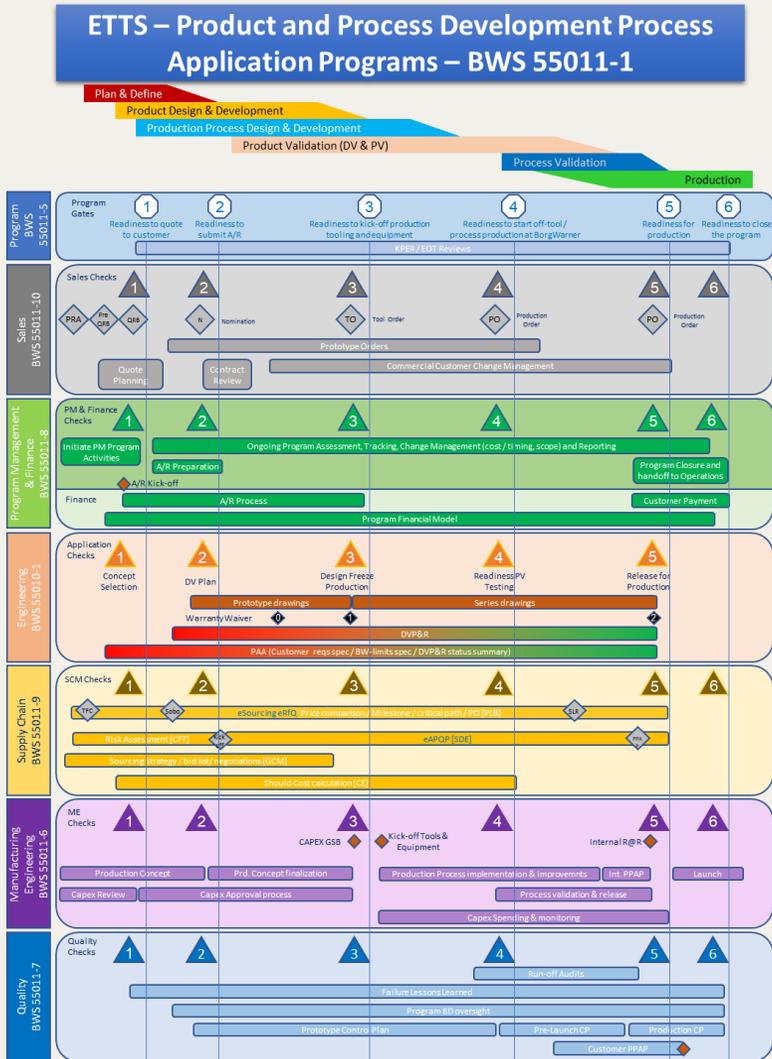
- Each product that is being developed goes through the Product Development Process (PDP).
- The PDP is an advanced development process carefully thought of by leadership team.
- For the new LPPD process to succeed, the LPPD process needed to be integrated into the PDP.

# Product Development Process (PDP) + LPPD



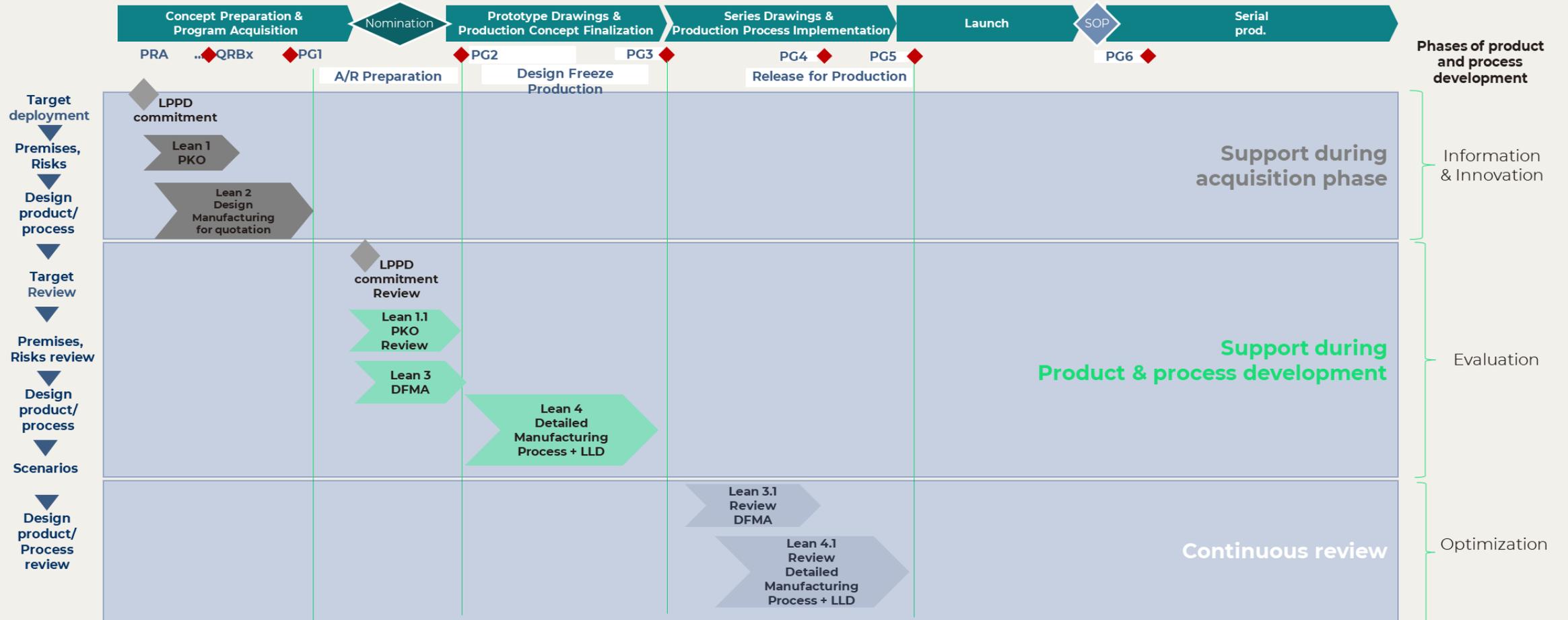
- The PDP is designed to have each function synchronize their work in order to meet deadlines.
- The functions interact at a minimum during the program gate reviews and design reviews.
- There are no assigned collaboration events, each function collaborates as they see fit.
- This method works well for simpler programs that do not involve new product and production technologies. (light level, carryover level programs)
- For more intense programs, LPPD needs to be applied.

# Workshop Timing with PDP



# LPPD: Program Kick-off (PKO) Workshop

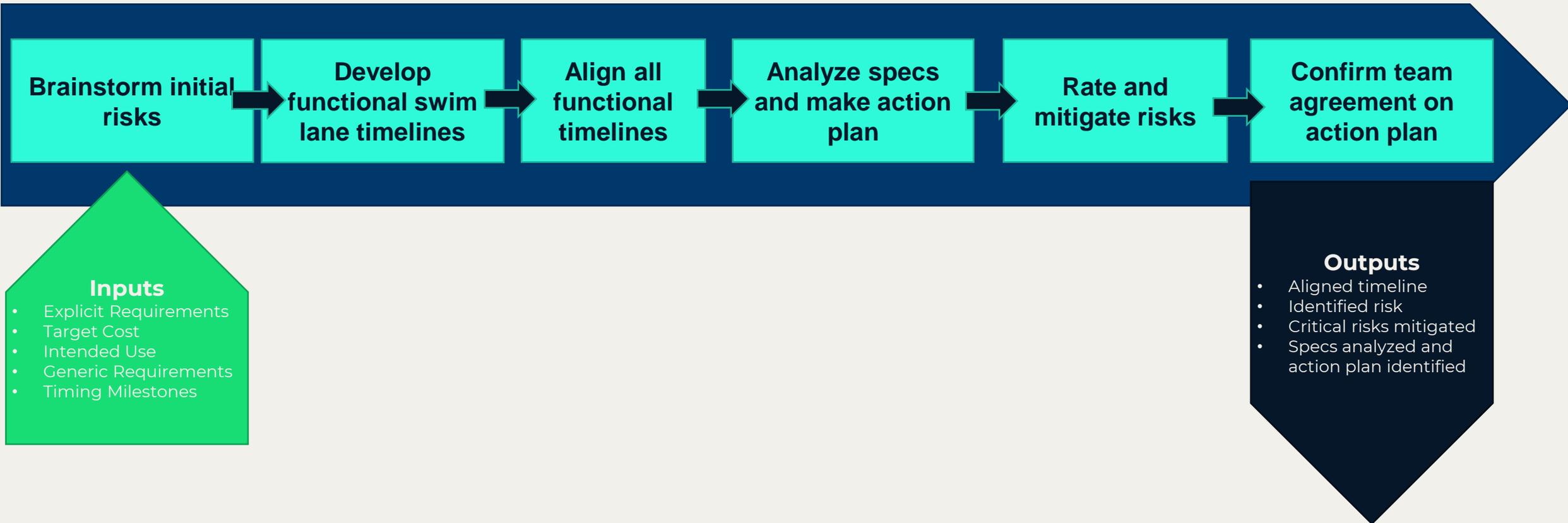
## ► LPPD Overview



# LPPD #1 – Program Kick Off (PKO)

- High level workshop, not very technical
- Focuses on:
  - Timeline
  - Specifications, internal and external
  - Risks
- Completed prior to the 2<sup>nd</sup> or 3<sup>rd</sup> round of quote to the customer

# LPPD: PKO Workshop Flow

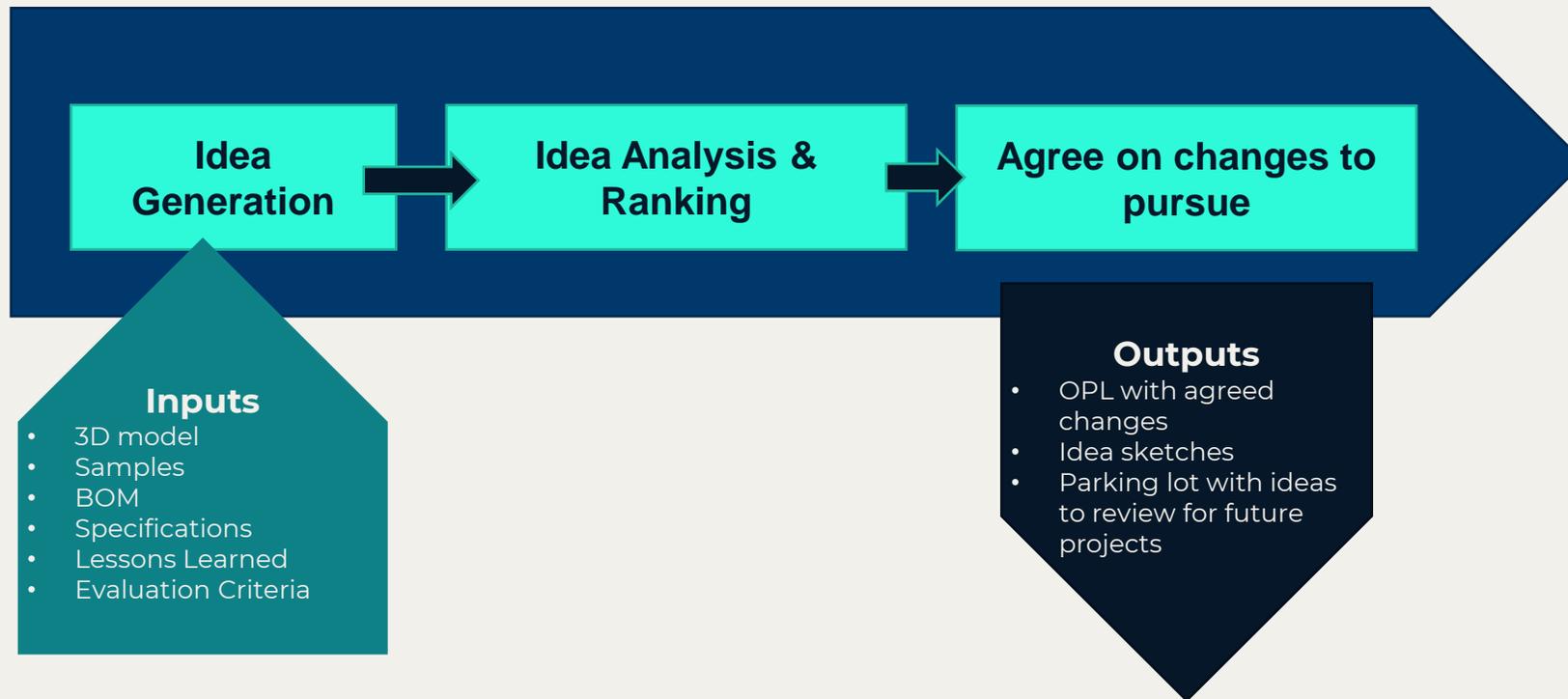


# LPPD #2 – Design and Manufacturing for Quotation (DMQ)

- Technical workshop, but with concept level design
- Completed prior to the 2<sup>nd</sup> or 3<sup>rd</sup> round of quote to the customer
- Makes quote more accurate and competitive.
- Focuses on:
  - Reducing cost for product design
  - Making design more manufacturable (DFMA)
  - Developing manufacturing process early
  - Estimating cycle time/operators
  - Risks

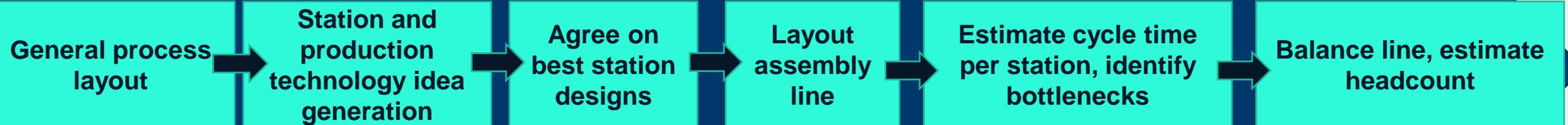
# LPPD: DMQ Workshop Flow

## ► Design Idea Generation



# LPPD: DMQ Workshop Flow

## ► Manufacturing Portion



### Inputs

- Preliminary manufacturing concept
- Updated design
- Lessons learned
- Cycle times from similar lines

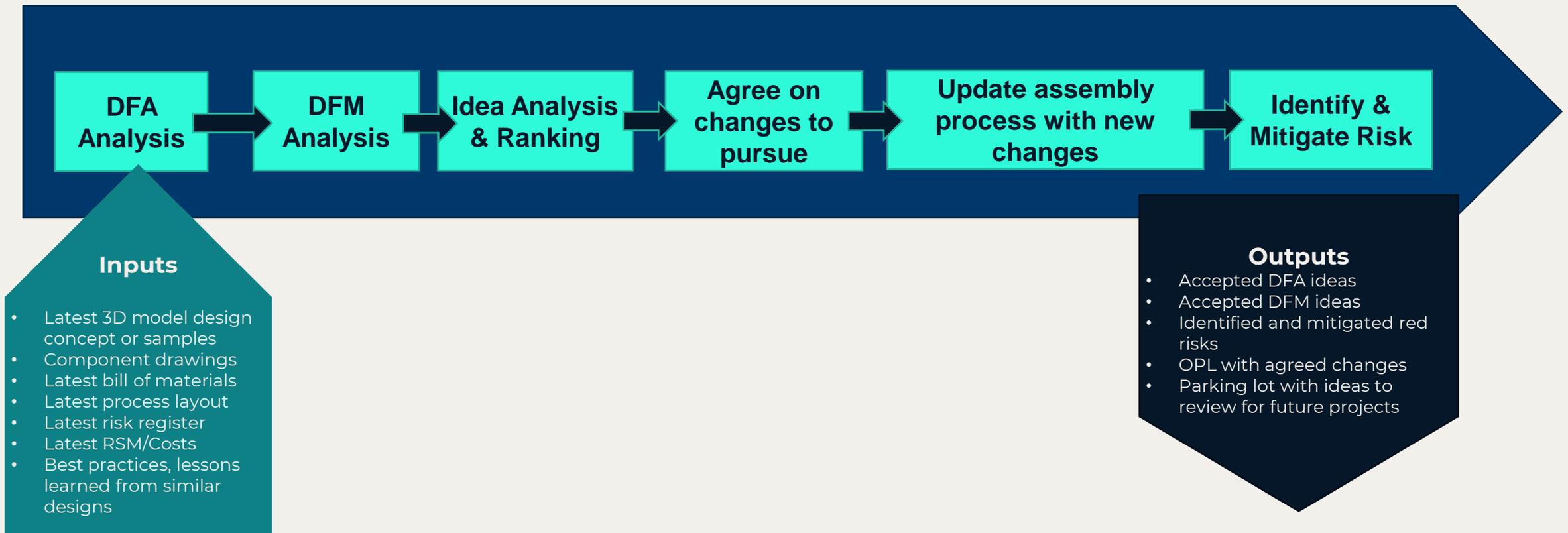
### Outputs

- OPL with agreed changes
- Station sketches
- Assembly line layout
- Estimated head count
- Confirmation of meeting capacity
- Parking lot with ideas to review for future projects

# LPPD #3 – Design for Manufacturing and Assembly (DFMA)

- Highly technical design-based workshop; after customer design freeze
- Small changes that help BorgWarner and won't shock the customer
- Completed later, prior to requesting money for capital expenditure
- Focuses on:
  - Deep dive into the design (sub-assembly and component drawing level)
  - Enhancing interfaces to become better to assemble for BorgWarner
  - Analyzing component tolerances to “right-size” for best quality and price
  - Adapting manufacturing process to updated design
  - Risks

# LPPD: DFMA Workshop Flow



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# LPPD #4 – Detailed Manufacturing Process and Lean Line Design (LLD)

- Highly technical process-based workshop
- Process is analyzed and developed in great detail
- Completed later, prior to kicking off equipment vendor
- Focuses on:
  - Sketching each station idea
  - Understanding equipment needs
  - Lean assembly layout proposals
  - Cycle time estimation & operator line balancing
  - Risks

# LPPD: LLD Workshop Flow

## Inputs

- Initial station concepts (Equipment, tooling, gages)
- Proposed head count
- Initial line layout
- Component packaging sizes
- Customer volumes/year for cycle time calculation

Identify technology needs per station

Identify equipment to be repurposed

Identify equipment specifics

Tooling & fixture sketches

Team agreement on machine specifics

Process & quality parameters

Line layout & flow

Cycle time estimation

Balance line & operators

Identify & Mitigate Risk

## Outputs

- Station concept w/ scalability
- Head count w/ balanced workload
- Line layout
- Identification of potential best practices in product and process
- Station, tooling, and gages detailed overview with poka yoke
- Packaging concept & general logistics
- New process design risk identification
- KPIs: CapEx savings, Head count, Cycle time to meet capacity

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# LPPD Facilitator Roles

# Program Risk Level – Selection

	Extended Program AAA	Standard Program AA	Light Program A	Capacity Uplift C	Variation V
<b>Product</b>					
•Technology	New	Existing	Carry-over	No product changes	Carry-over
•DVP&R	<del> </del>	Full	Reduced Application specific	Only PV	None / Change specific
<b>Production Process</b>					
•Technology	New	Existing	Carry-over	Carry-over	Carry-over
•Production	<del> </del>	New equipment	New tools & fixtures	New equipment	Minor changes

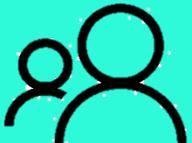
Meets any criteria

Meets all criteria

# LPPD & Program Levels

**LPPD Application**

**Programs AAA**



Lead by **Global Facilitators**

Commitment: LPPD Steering Meeting



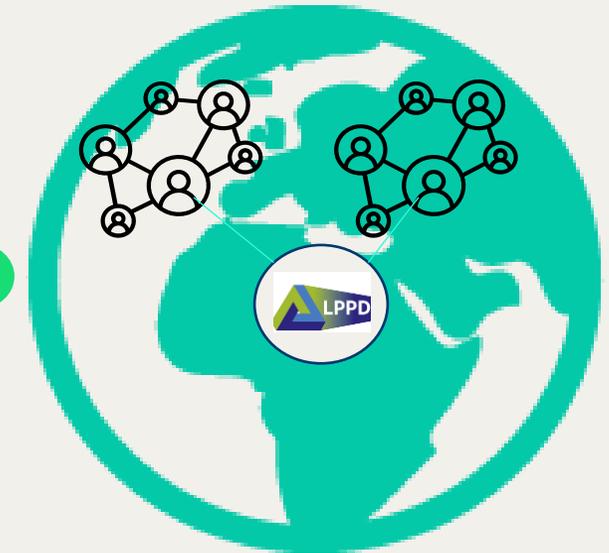
**LPPD Application**

**Programs AA**



Facilitated by **Local Facilitators**

Commitment: Plant Decision



# LPPD: Roles & Responsibilities

## Local LPPD Facilitators

### Champion LPPD Processes at their Site

- Promoting LPPD in their site
- Planning & Facilitating LPPD workshop for local programs (AA)
- Follow-up local LPPD activities and exchange with global team
- Promote workshop results for reuse in other applications

## Global LPPD Facilitators

### Champion LPPD Processes in ETTS

- Define, benchmark & Optimize the LPPD process integrated in PDP
- Promoting LPPD within ETTS
- Planning & Facilitating LPPD workshop with focus on key programs (AAA)
- Develop & deploy training concept for local facilitators
- Maintaining Global LPPD community
- Coaching local LPPD Facilitators & exchange of experience
- Follow-up on **all** LPPD activities & results
- Promote workshop results for reuse in other applications



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# LPPD Facilitator Training

# Facilitator Certification Levels



## Level 1: Padawan

- ✓ Fundamental Awareness
- ✓ Progressing through local facilitator theory and training courses



## Level 2: Knight

- ✓ Novice level
- ✓ Completed local facilitator theory and training courses
- ✓ Can run workshops with a mentor



## Level 3: Master

- ✓ Intermediate level
- ✓ Has facilitated LPPD workshops 1-4 both with a mentor and independently.
- ✓ Able to run all workshops independently at their local site.



## Level 4: Grandmaster

- ✓ Advanced level
- ✓ Extensive experience: Has facilitated LPPD workshops 1-4 many times independently.
- ✓ Able to provide recommendations to improve the LPPD process



## Level 5: Yoda

- ✓ Recognized Authority on LPPD
- ✓ Vast experience with LPPD facilitation and PDP integration
- ✓ Oversees the LPPD process improvements



# Facilitator Development Topics

## LPPD Local Facilitator Curriculum

	Topics	Teaching Type	
	Introduction	Live online	<b>Padawan Level Achieved</b>
<b>Stage 1: Theory</b>	Lean Product Development (TPDS)	Live online	
	PDP	Spark e-learning	
	LPPD Overview	Live online/recorded	
	LPPD Details (Integration into PDP and methodology)	Live online/recorded	
	High Level Workshop Explanation	Live online/recorded	
	Workshop Roles Explanation	Live online/recorded	
	Facilitation Basics	Spark e-learning	
<b>Stage 2: Training</b>	In-Depth Workshop Training Sprint Details How-To Facilitate Sprints Small Group Simulation (learn by doing)	In-person, Altogether Min:6 Max:12	
	Preparing a Workshop	In-person, Altogether	
	Post Workshop Activities	In-person, Altogether	<b>Knight Level 1 Achieved</b>
<b>Stage 3: Workshop Application</b>	Run LPPD 1 Workshop with mentor	F2F (Opportunity Based)	
	Run LPPD 2 Workshop with mentor	F2F (Opportunity Based)	
	Run LPPD 3 Workshop with mentor	F2F (Opportunity Based)	
	Run LPPD 4 Workshop with mentor	F2F (Opportunity Based)	
	Run LPPD 1 Workshop independently	F2F (Opportunity Based)	<b>Knight Level 2 Achieved</b>
	Run LPPD 2 Workshop independently	F2F (Opportunity Based)	<b>Knight Level 3 Achieved</b>
	Run LPPD 3 Workshop independently	F2F (Opportunity Based)	<b>Knight Level 4 Achieved</b>
	Run LPPD 4 Workshop independently	F2F (Opportunity Based)	<b>Master Level Achieved</b>

# First Stage 2 Training – Viana do Castelo, Portugal



## Trainee Locations

USA

China

Spain

Portugal

India

Poland

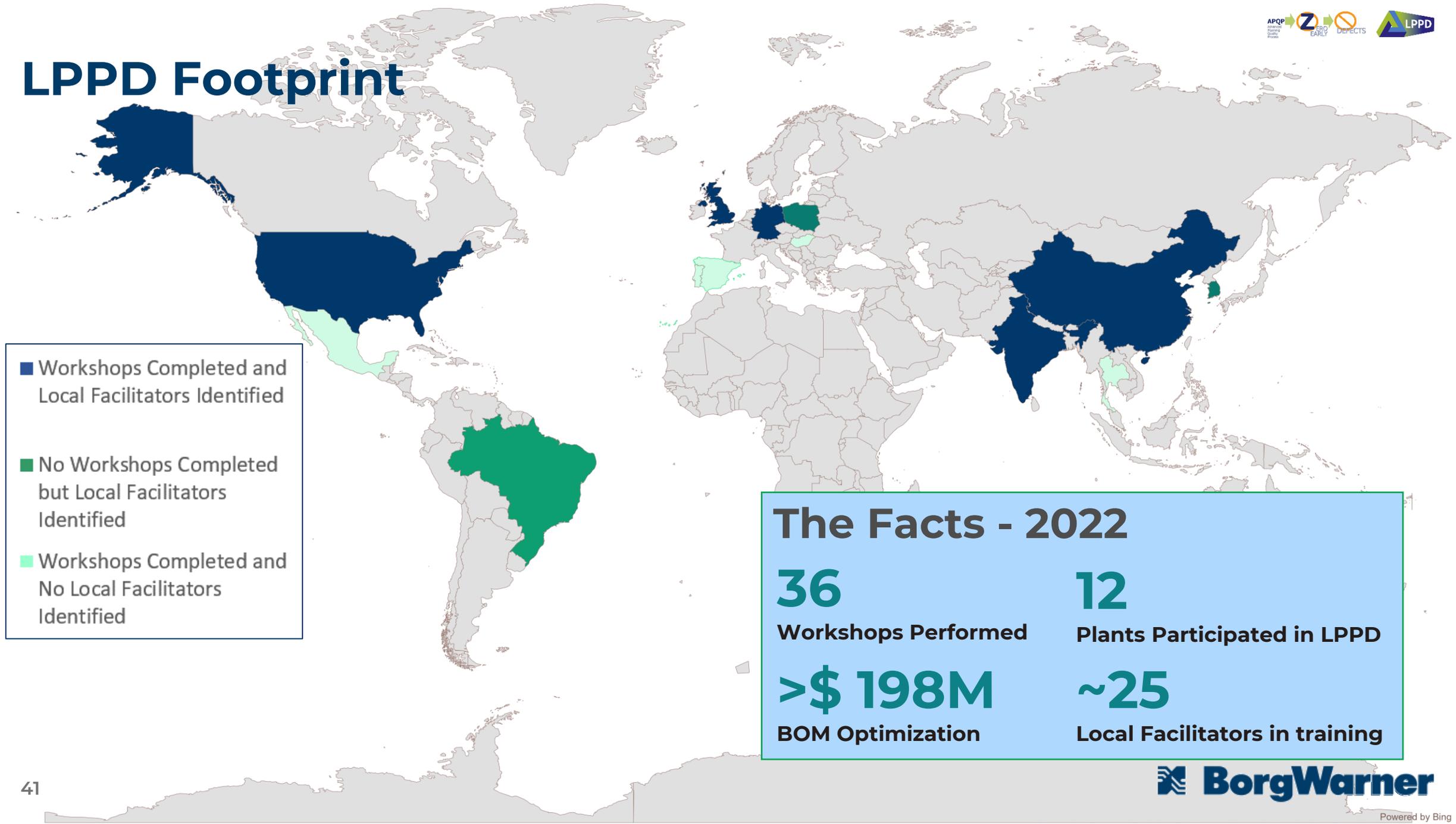
United Kingdom

South Korea

Germany

Brazil

# LPPD Footprint



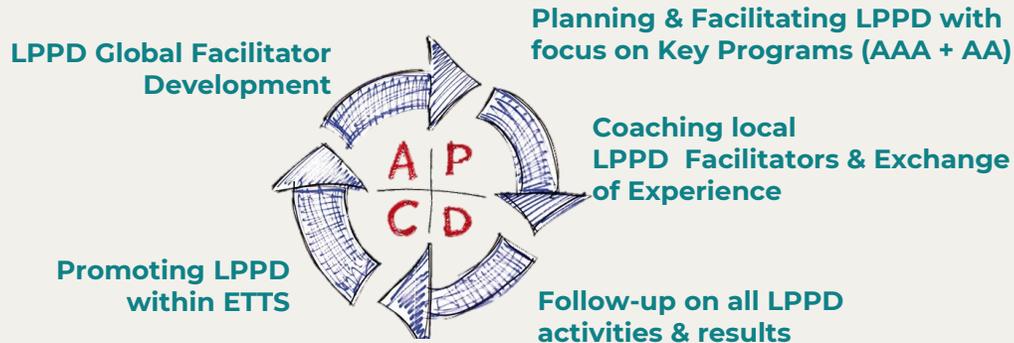
- Workshops Completed and Local Facilitators Identified
- No Workshops Completed but Local Facilitators Identified
- Workshops Completed and No Local Facilitators Identified

## The Facts - 2022

<b>36</b> Workshops Performed	<b>12</b> Plants Participated in LPPD
<b>&gt;\$ 198M</b> BOM Optimization	<b>~25</b> Local Facilitators in training

# LPPD Strategy for 2023

## PDCA



## Key Milestones



## LPPD Targets

Product Cost Optimization: **\$50M**  
 Equipment Cost Avoidance: **\$4M**  
 Production Costs Optimization: **\$4M**  
 Red Risks Mitigated: **100%**

## YTD

**~\$45M**  
**~\$6M**  
**~\$10M**  
**100%**

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