

BORGWARNER

LPPD Culture Within BorgWarner

LPPDE Virtual Conference

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Company Overview

A stylized world map in a dark teal color serves as the background for the slide. On the left side, there is a solid teal vertical bar.

BorgWarner

In Numbers

~38k
Employees

\$15.8
Billion in
2022 Sales

80
Locations

19
Countries



Strategic Global Operations

27

Locations in
the Americas

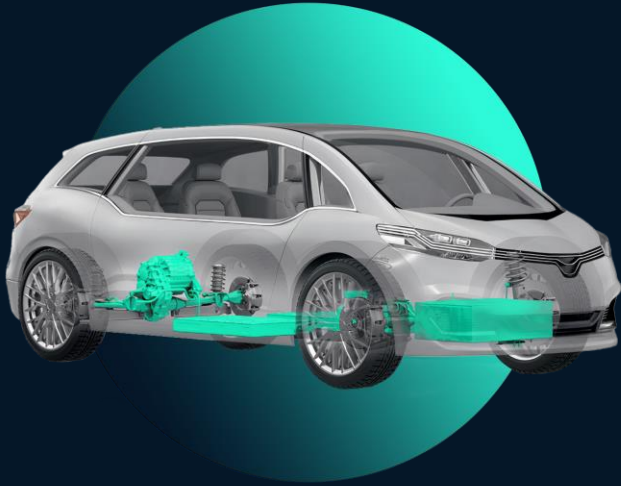
23

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



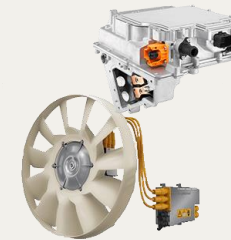
Electric Drive Motors



Electric Drive Modules

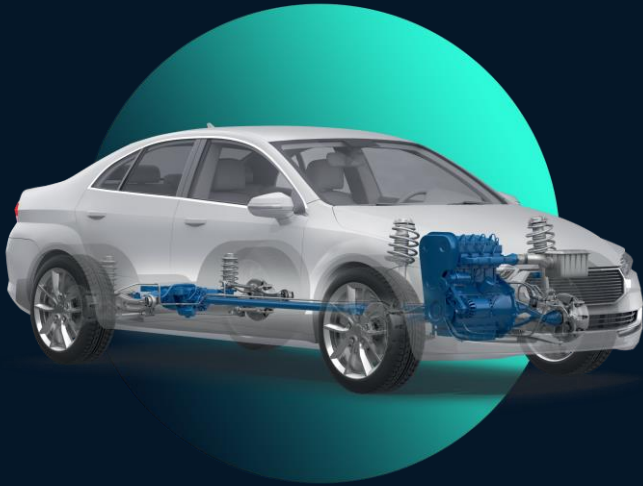


Power Electronics



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



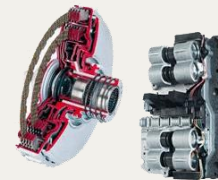
P1 Hybrid Architecture



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

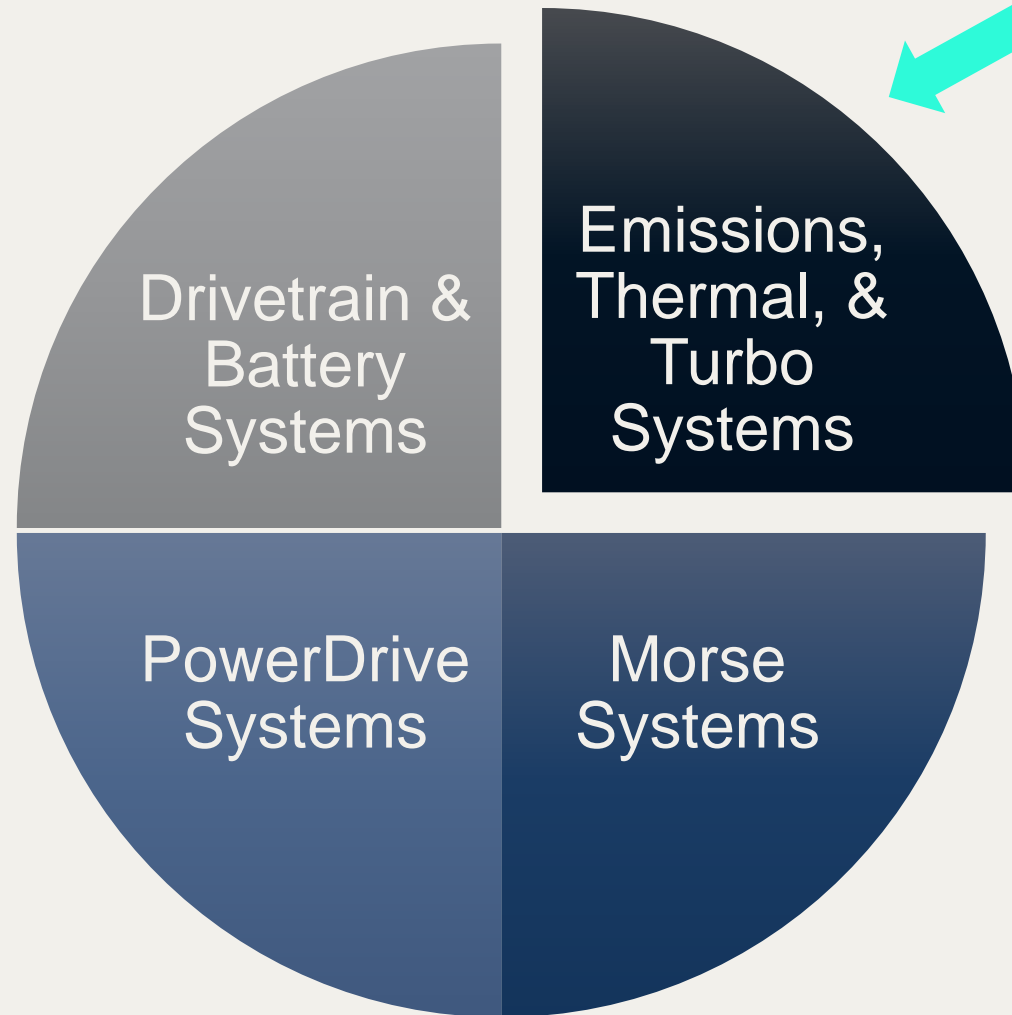


Power Electronics



Thermal Management

Business Units of BorgWarner



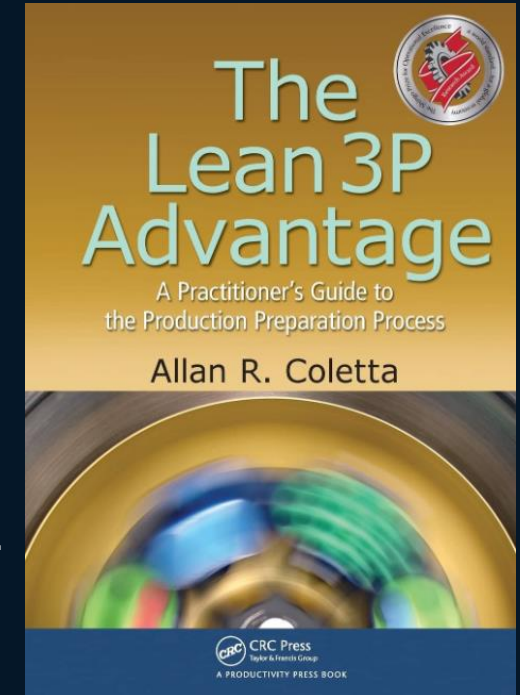
The remaining slides apply to the Emissions, Thermal, & Turbo Systems (ETTS) business unit.

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LPPD History at BorgWarner

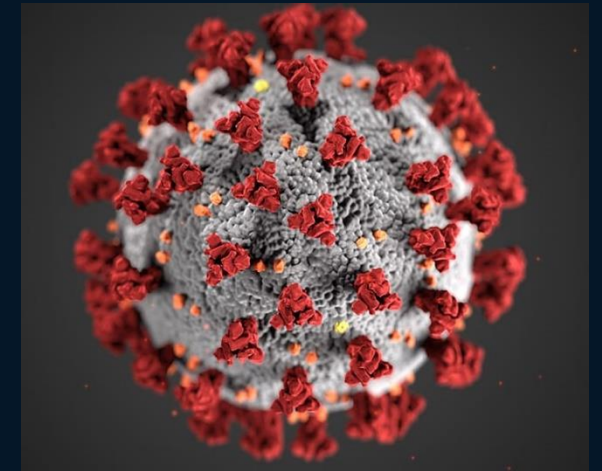
LPPD History at BorgWarner

- 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



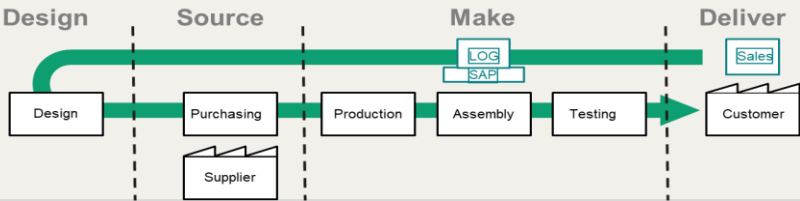
Optimize our Products & Processes by collaborating early in the PDP to increase competitiveness in Quality, Timing & Cost.

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

Essentials

Broad and
Deep
Expertise

Business
Orientation

Collaboration

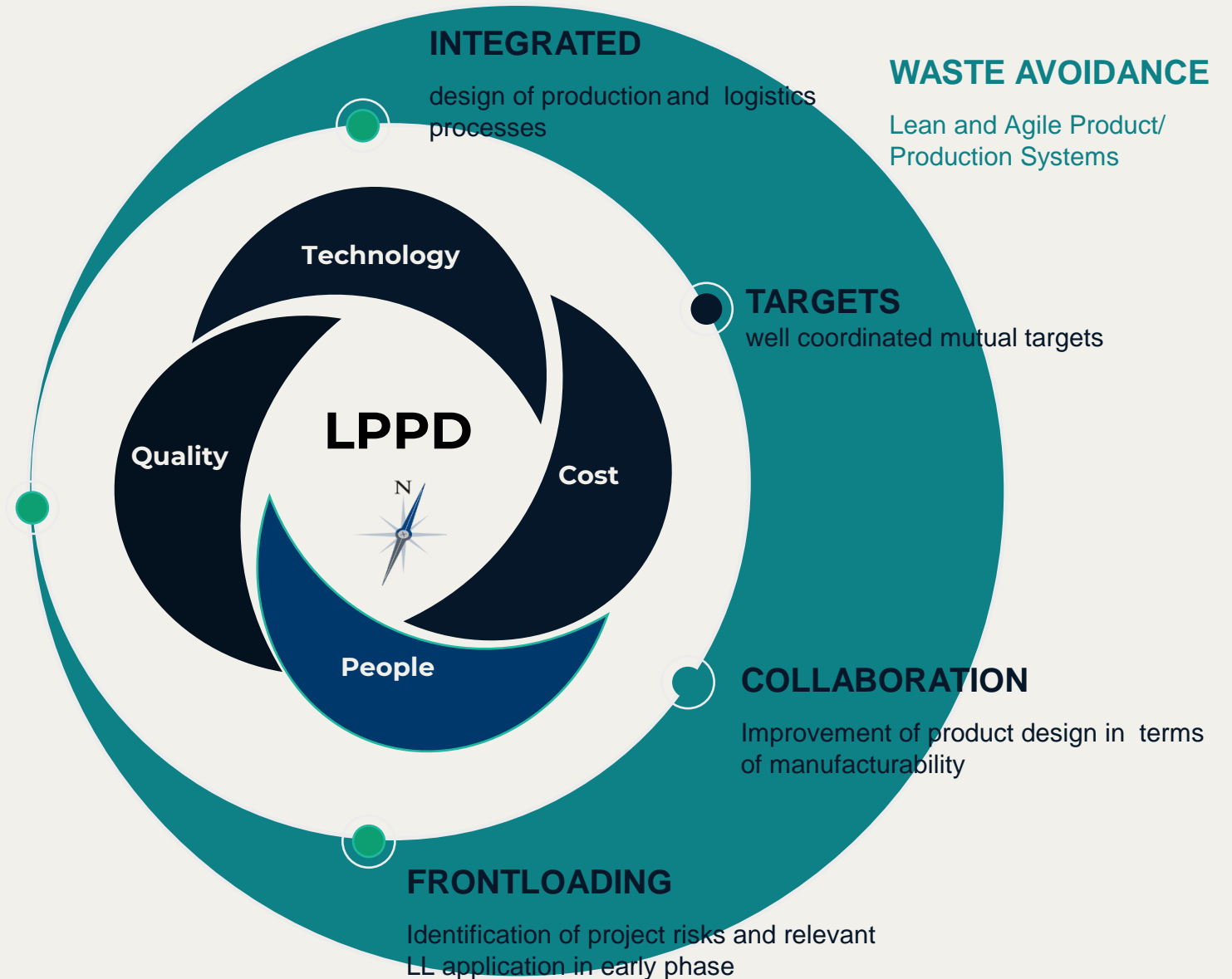
Quality

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What is LPPD?



EARLY INVOLVEMENT
of all program relevant functions

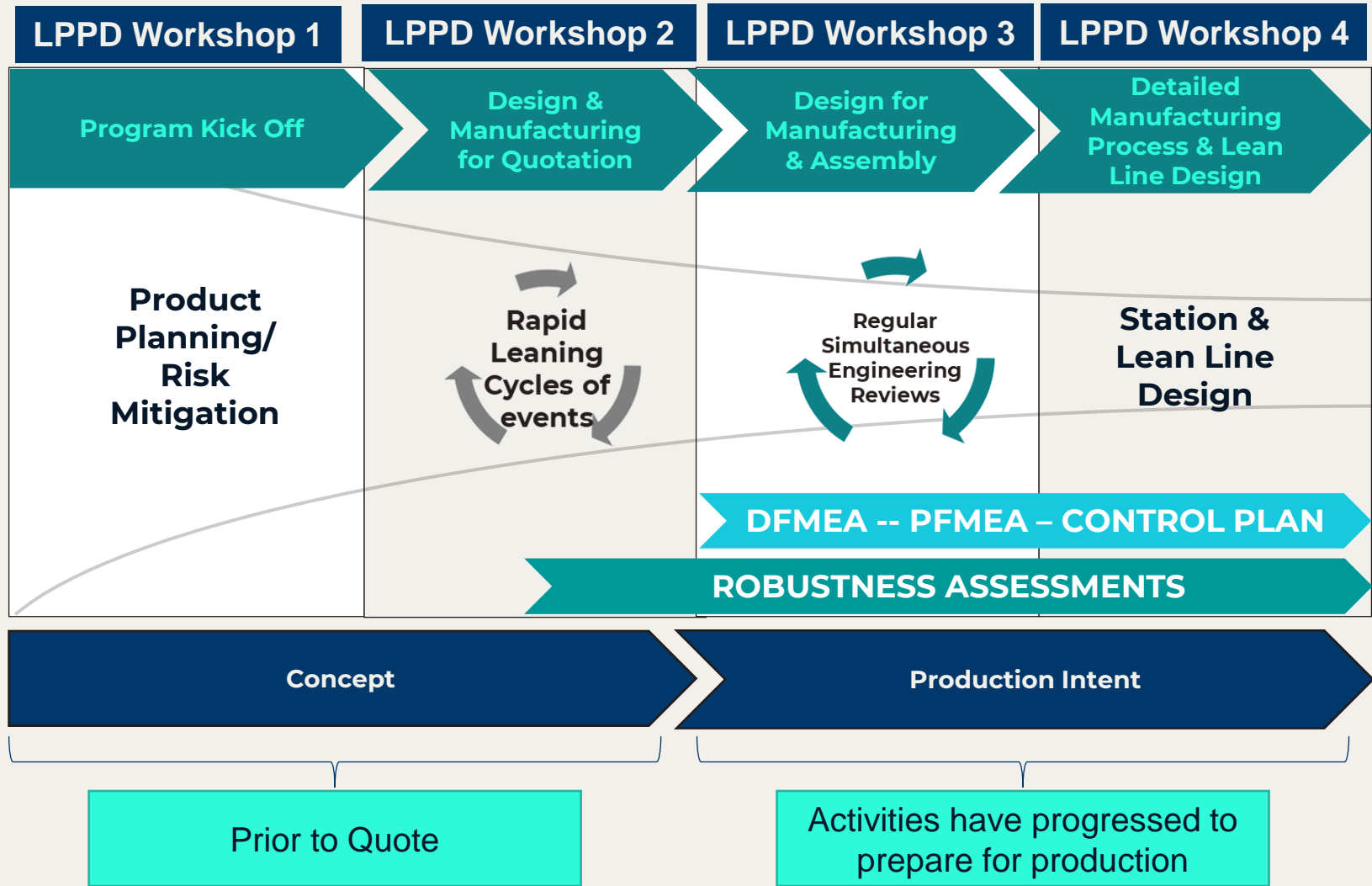


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LPPD Workshops

- 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

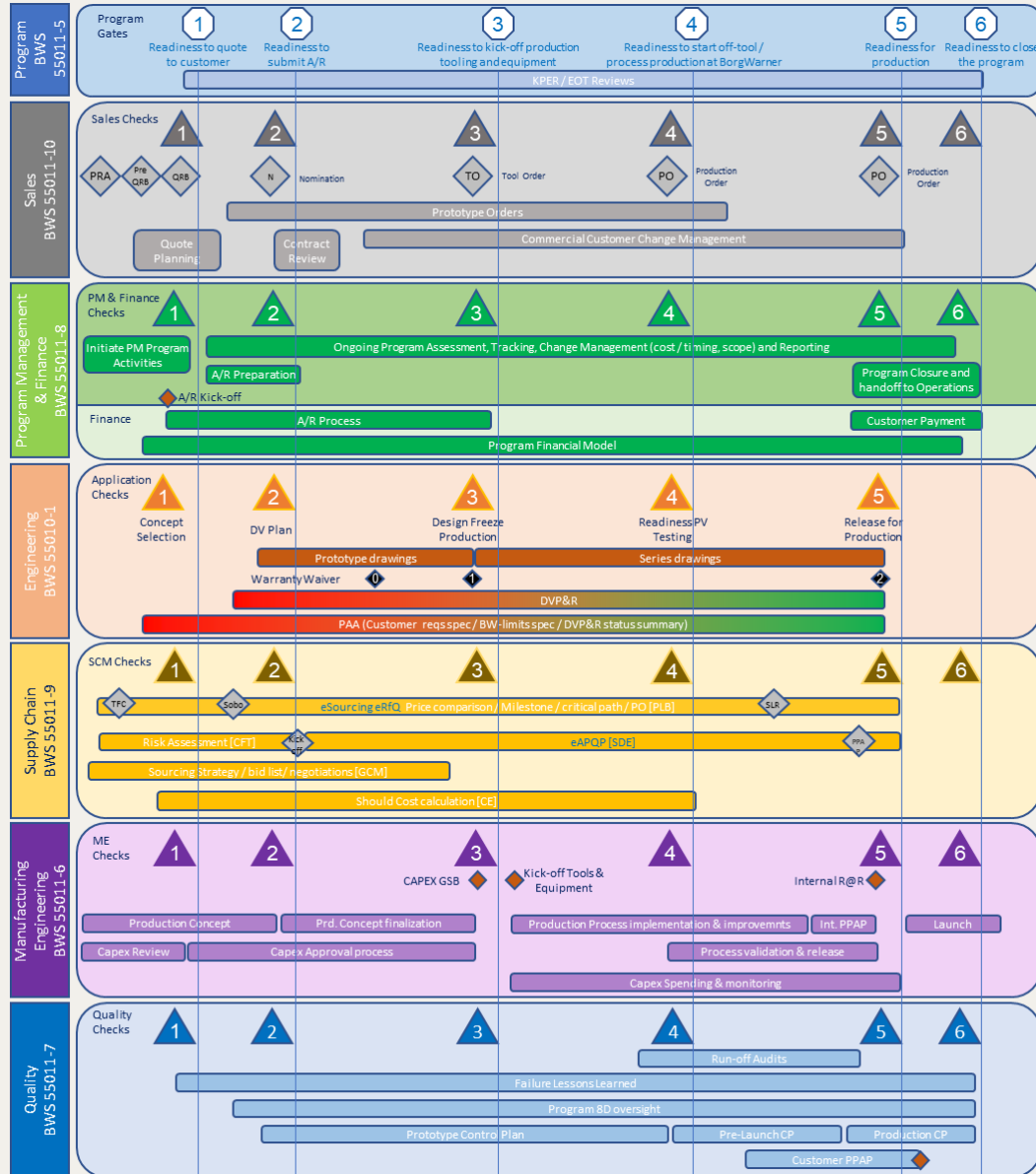
Workshop Function	LPPD 1 PKO	LPPD 2 Design & Manufacturing for Quotation	LPPD 3 DFMA	LPPD 4 Detailed Manufacturing Process and Lean Line Design
Facilitator				
LPPD Facilitator	M	M	M	M
Program Management				
Global Program Manager (if applicable)	M	M	M	M
Program Manager	M	M	M	M
Engineering & Application				
Engineering (R&D)	M	M	M	O
Application Engineer	M	M	M	O
Designer	O	M	M	O
Supply Chain				
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
Quality				
Advanced Quality Engineer	M	M	M	M
Manufacturing				
Local Manufacturing Engineering	M	M	M	M
Global Manufacturing Engineering	M	M	M	
Product Leader	M	M	M	M
Logistics				
Logistics Coordinator	O	O	O	M
Production				
Operations Management	O	M	M	M
Continuous Improvement	O	M	O	M
Finance & Sales	O	O	O	O
External				
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

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LPPD Process

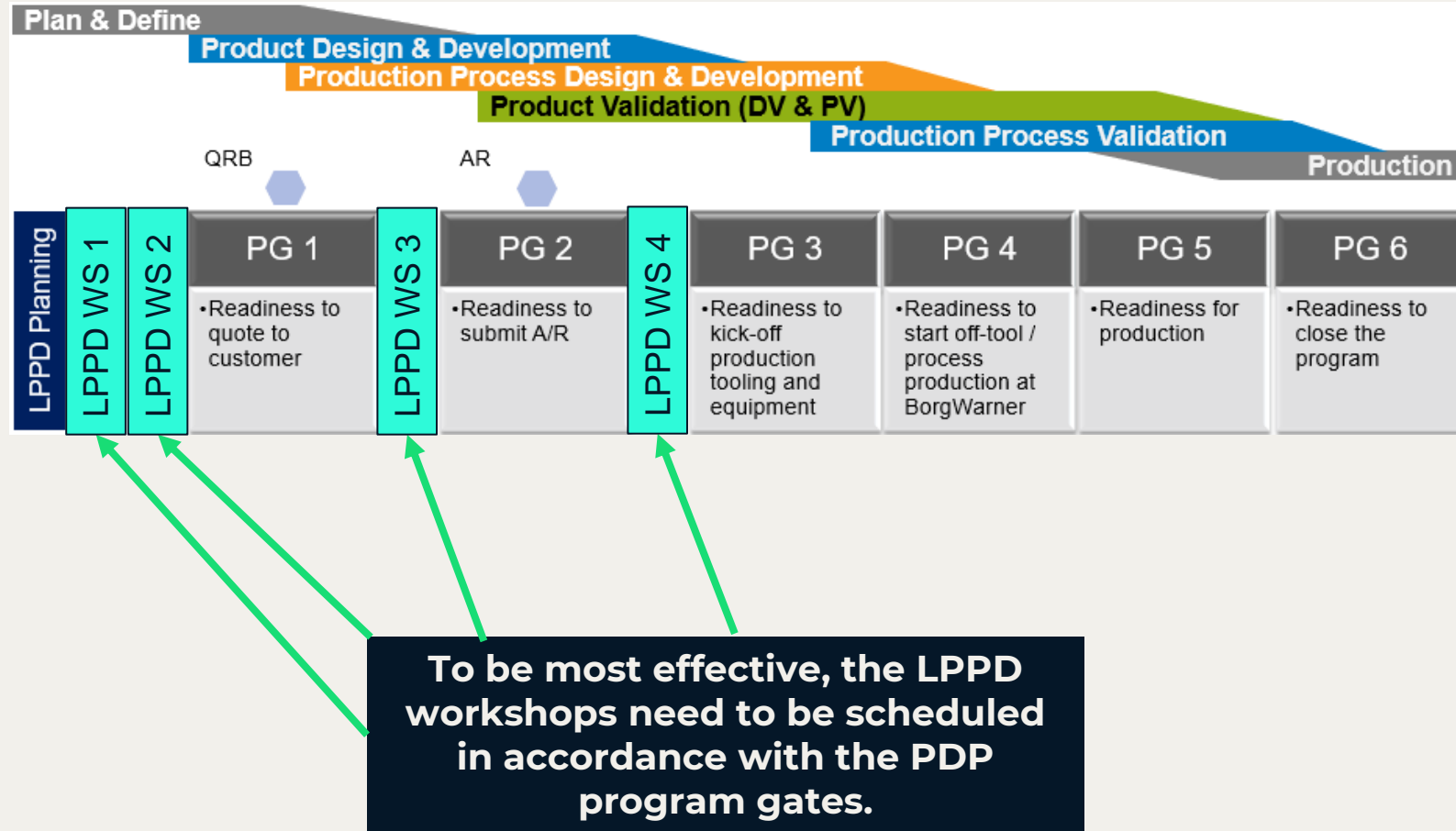
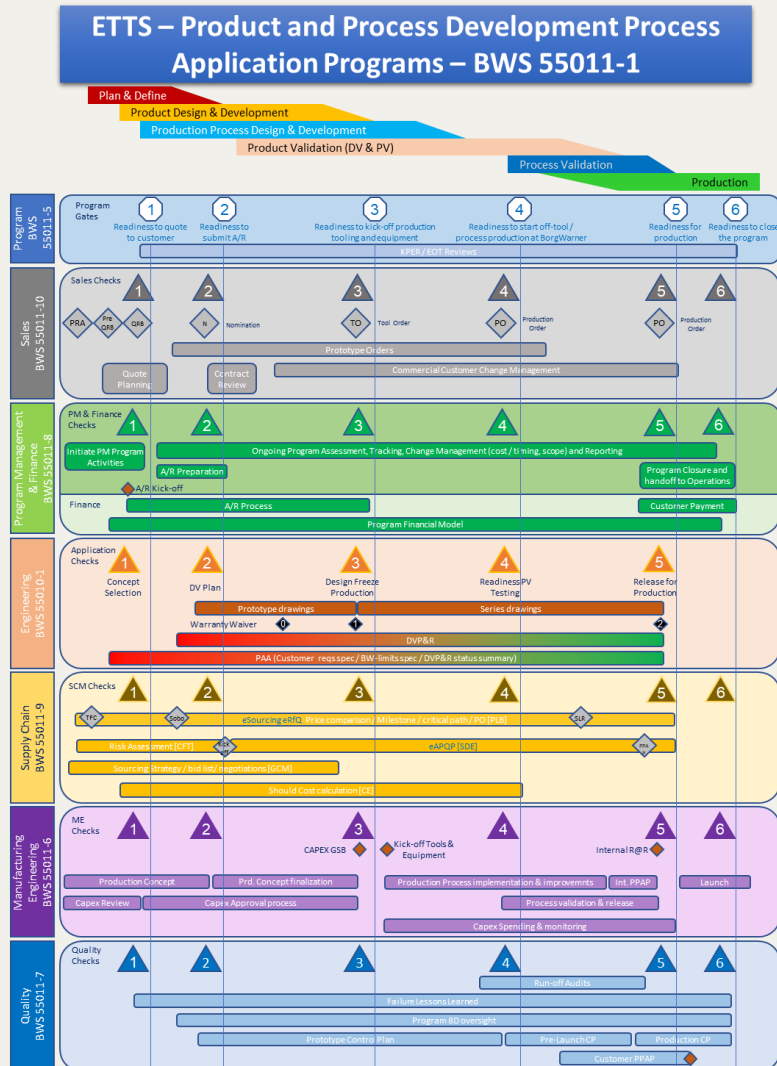
- Each product that is being developed goes through the Product Development Process (PDP).
- The PDP is an advanced development process carefully thought of by leadership team.
- For the new LPPD process to succeed, the LPPD process needed to be integrated into the PDP.

Product Development Process (PDP) + LPPD



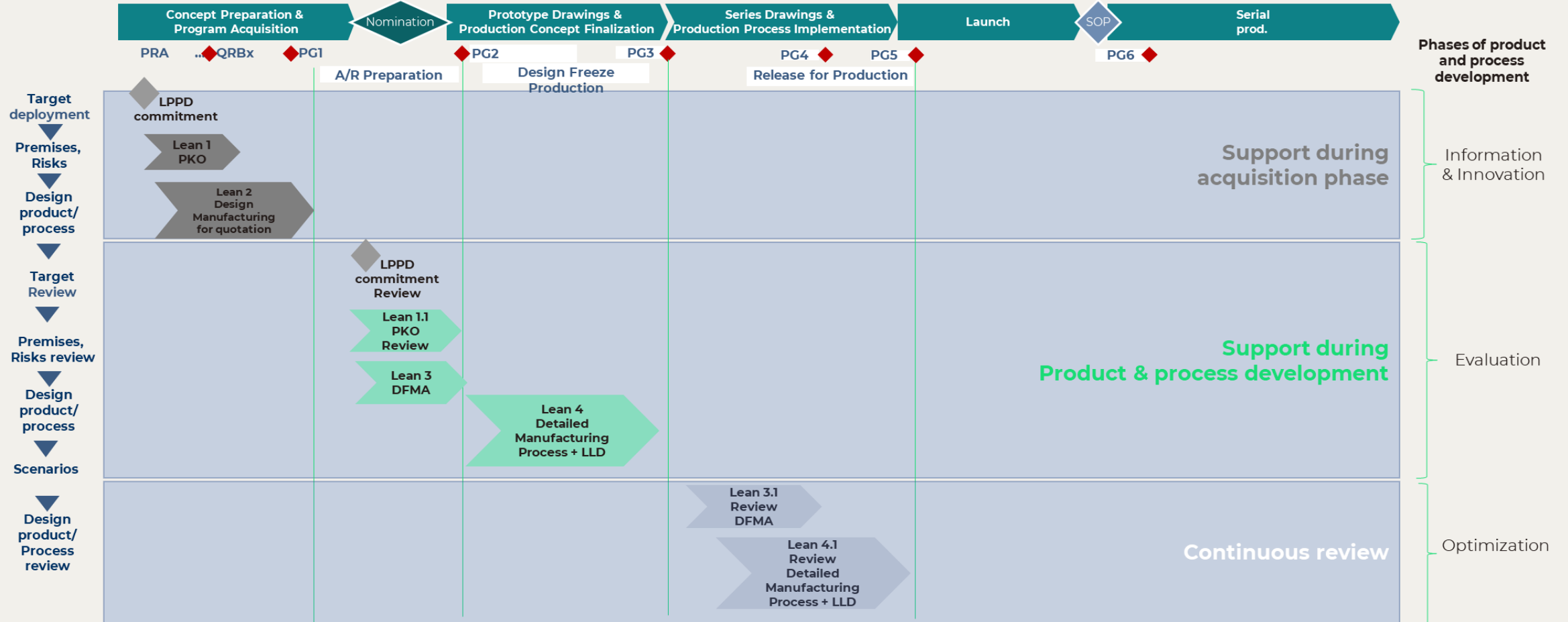
- The PDP is designed to have each function synchronize their work in order to meet deadlines.
- The functions interact at a minimum during the program gate reviews and design reviews.
- There are no assigned collaboration events, each function collaborates as they see fit.
- This method works well for 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

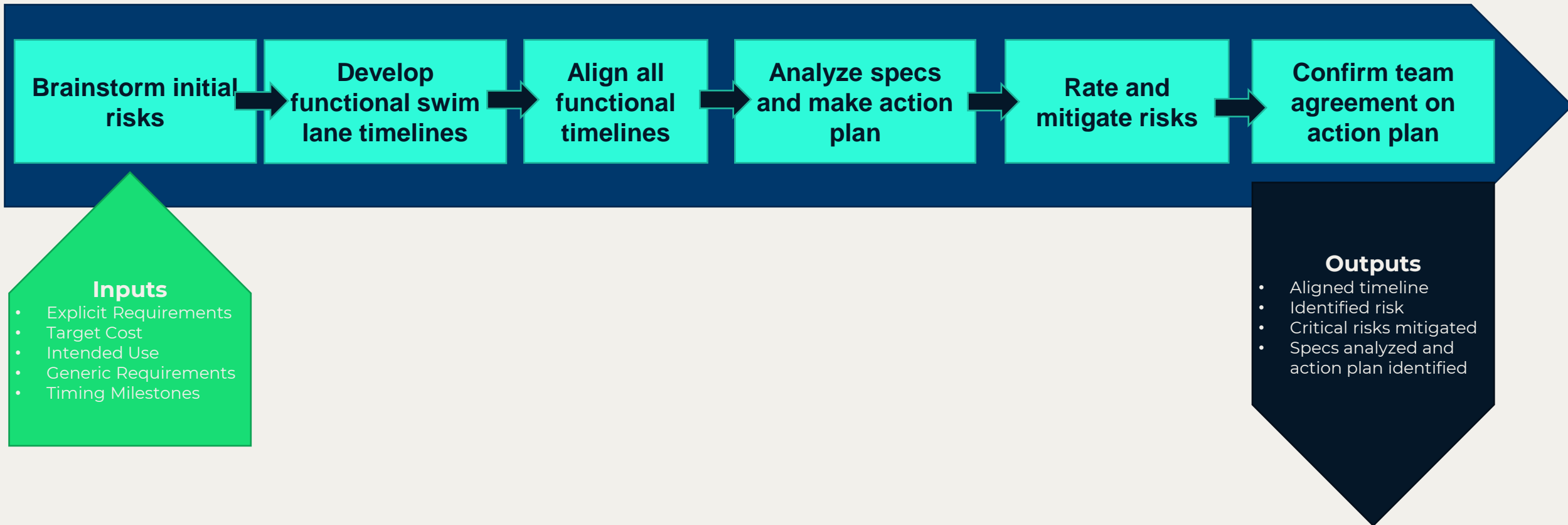
► LPPD Overview



LPPD #1 – Program Kick Off (PKO)

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

LPPD: PKO Workshop Flow



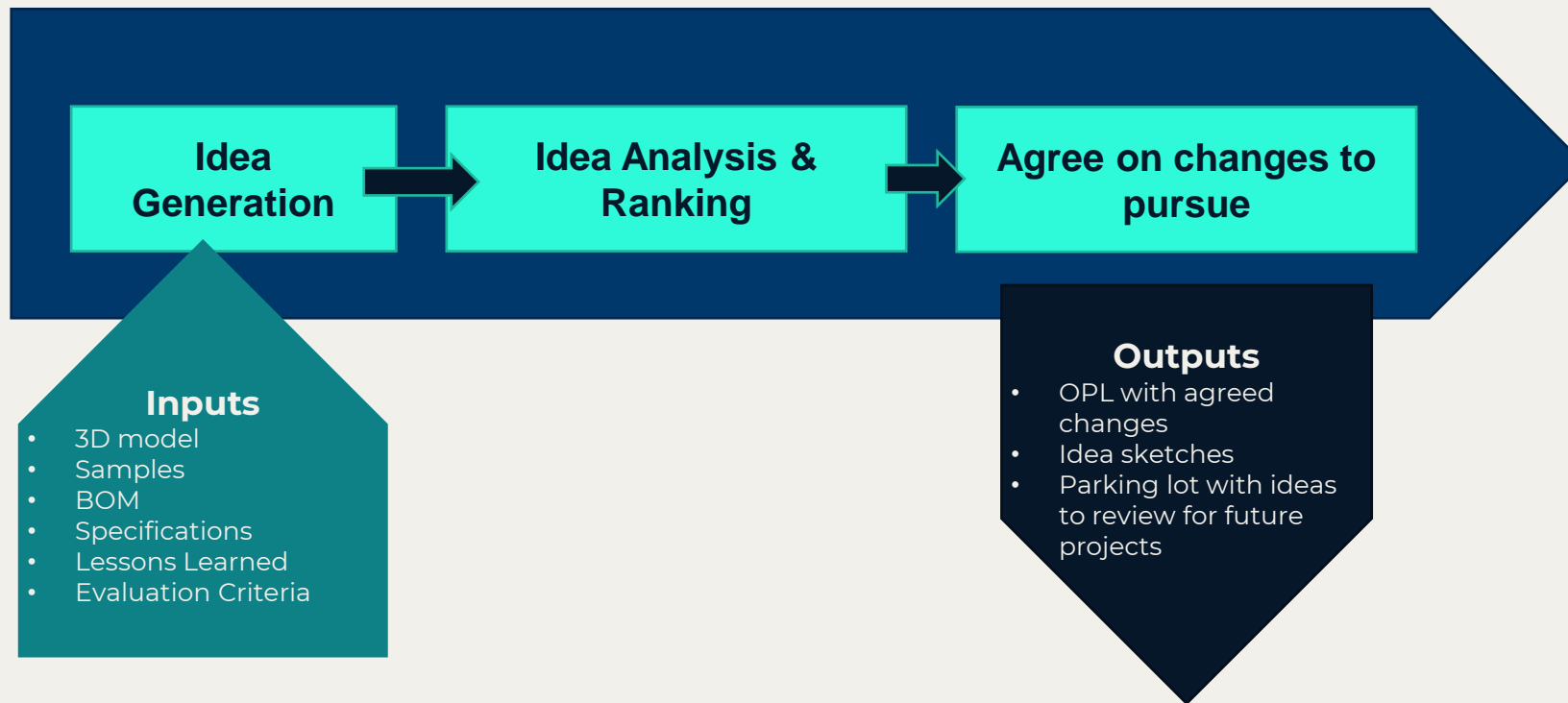
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LPPD #2 – Design and Manufacturing for Quotation (DMQ)

- Technical workshop, but with concept level design
- Completed prior to the 2nd or 3rd 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

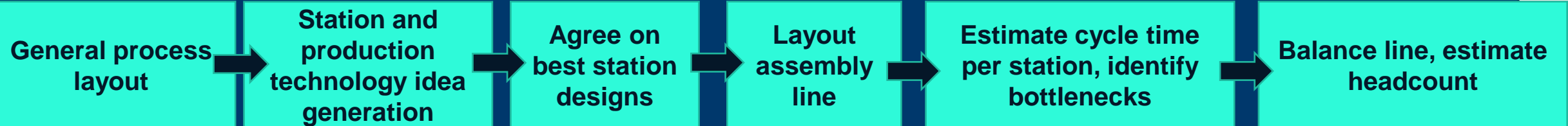
LPPD: DMQ Workshop Flow

► Design Idea Generation



LPPD: DMQ Workshop Flow

► Manufacturing Portion



Inputs

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

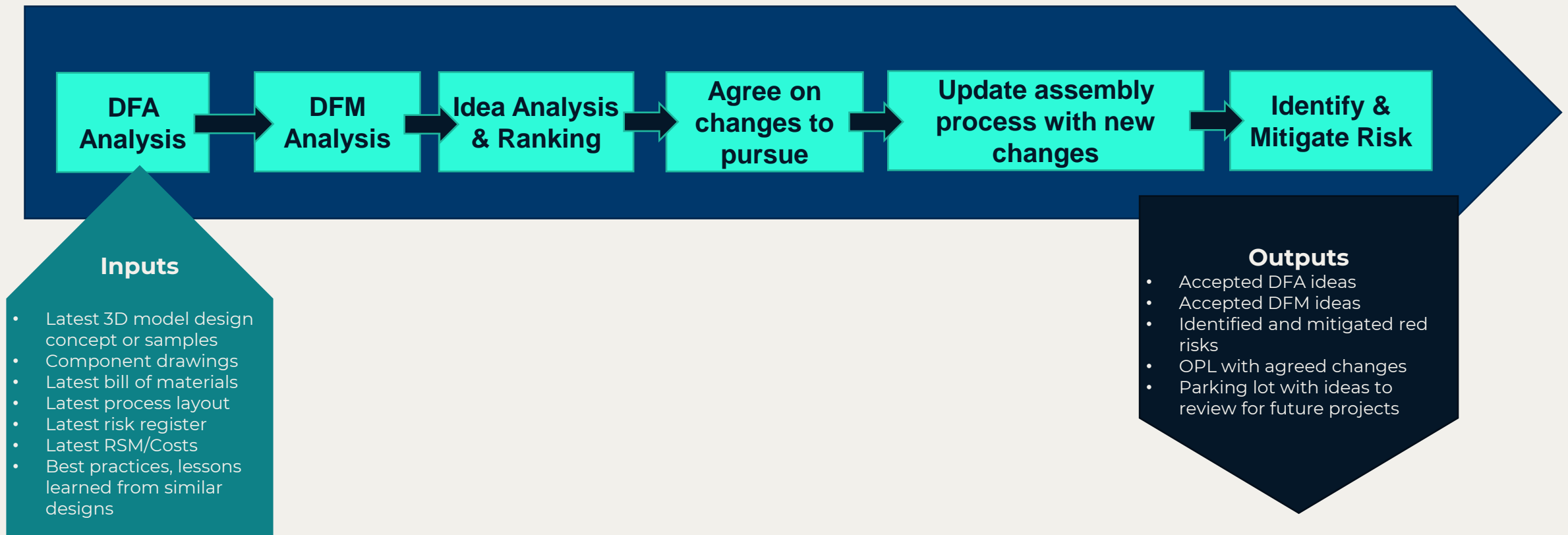
Outputs

- 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
Product					
•Technology	New	Existing	Carry-over	No product changes	Carry-over
•DVP&R		Full	Reduced Application specific	Only PV	None / Change specific
Production Process					
•Technology	New	Existing	Carry-over	Carry-over	Carry-over
•Production		New equipment	New tools & fixtures	New equipment	Minor changes

Meets any criteria

Meets all criteria

LPPD & Program Levels



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	Padawan Level Achieved
Stage 1: Theory	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	
Stage 2: Training	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	Knight Level 1 Achieved
Stage 3: Workshop Application	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)	Knight Level 2 Achieved
	Run LPPD 2 Workshop independently	F2F (Opportunity Based)	Knight Level 3 Achieved
	Run LPPD 3 Workshop independently	F2F (Opportunity Based)	Knight Level 4 Achieved
	Run LPPD 4 Workshop independently	F2F (Opportunity Based)	Master Level Achieved

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First Stage 2 Training – Viana do Castelo, Portugal



Trainee Locations

USA

China

Spain

Portugal

India

Poland

United Kingdom

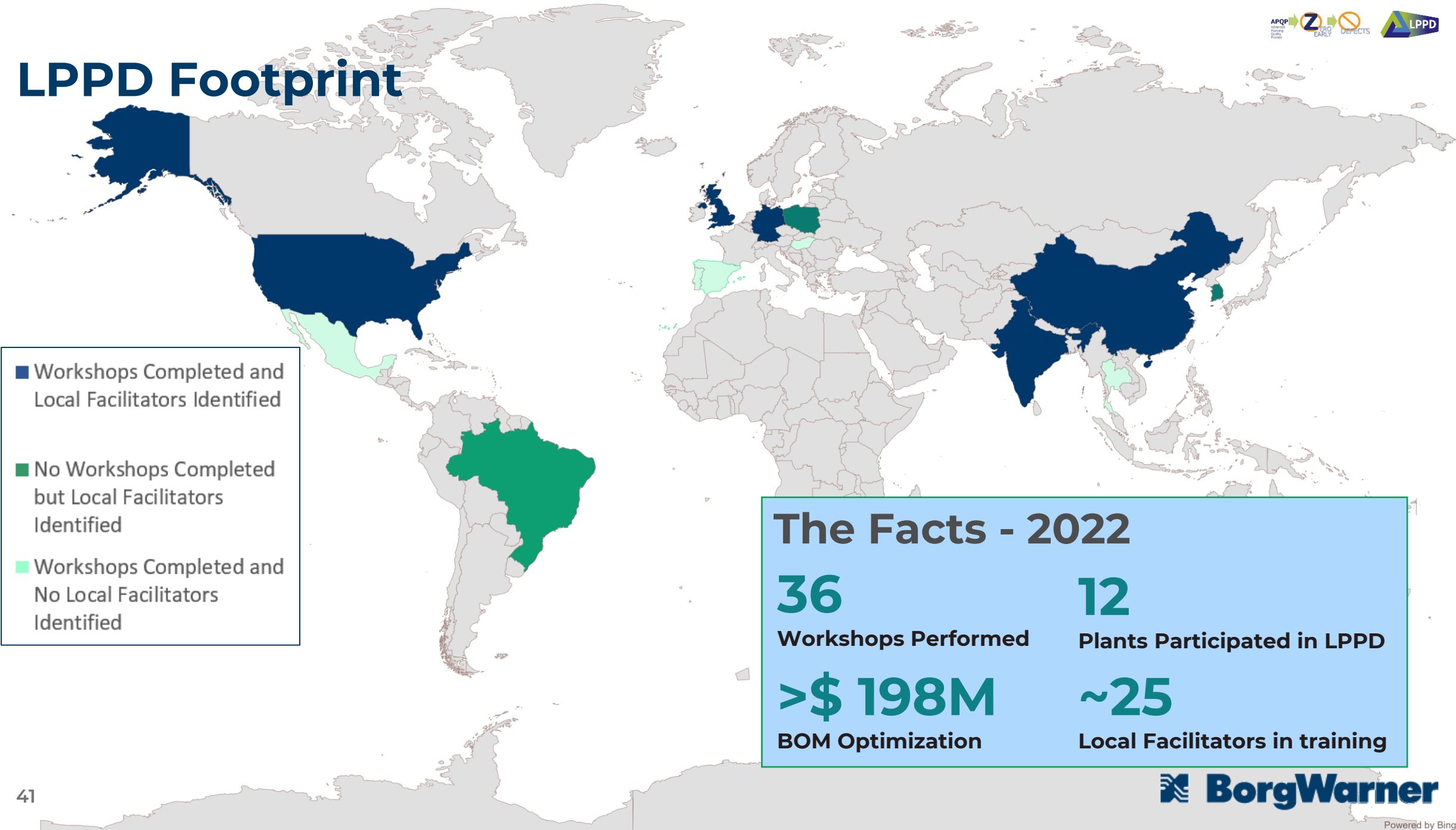
South Korea

Germany

Brazil

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LPPD Footprint



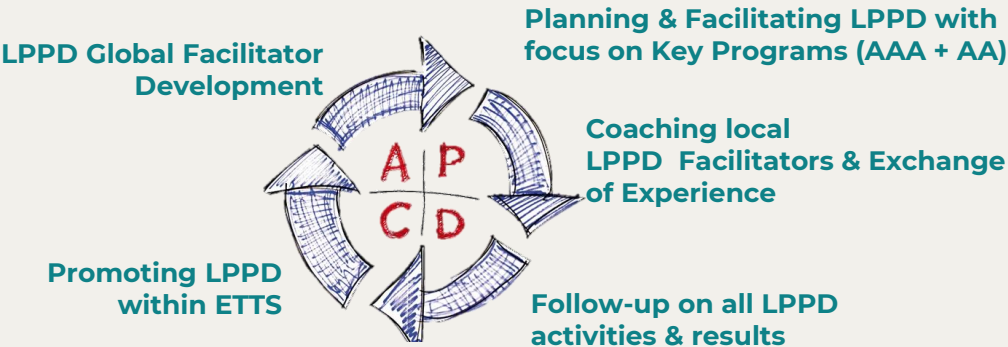
- Workshops Completed and Local Facilitators Identified
- No Workshops Completed but Local Facilitators Identified
- Workshops Completed and No Local Facilitators Identified

The Facts - 2022

36	12
Workshops Performed	Plants Participated in LPPD
>\$ 198M	~25
BOM Optimization	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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