Project Management

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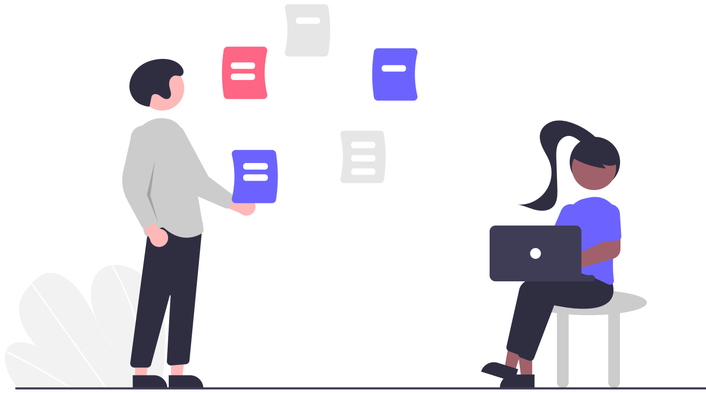
Definition of Project & Successful Standard

- A project is goal-oriented, producing a unique deliverable or set of deliverables.
- A project consists of connected, related activities.
- A project has limited duration (main characteristic differ from operation), which means projects are typified by a predefined schedule and usually tied to a specific end date.
- A project has elements of uniqueness.
- Projects are defined by three constraints which must be managed: time, cost, and scope (work content) of the project.

- On-time
- On-budget
- High-quality
- Fulfilled objectives
- Satisfied customers
- Achieved outcomes



Three Different Types of Project Lifecycles

Predictive Lifecycle:

- **Characteristics**: At the beginning of the project, detailed planning is done for the project scope, schedule, and cost, and changes are strictly controlled throughout the project. The project progresses sequentially through phases such as initiation, planning, execution, monitoring, and closing.
- **Applicability**: Suitable for projects with clear and stable requirements, such as construction projects or traditional manufacturing projects.
- **Advantages**: Provides detailed plans and clear control points, enabling project managers to better control the project schedule and budget.

Adaptive Lifecycle:

- **Characteristics**: Also known as the Agile Lifecycle, this type emphasizes rapid response to changes and continuous improvement. Project work is conducted in short cycles of iterations (such as Sprints in Scrum), with each iteration completing a potentially deliverable product increment.
- **Applicability**: Suitable for projects with frequently changing or unclear requirements, such as software development or highly innovative R&D projects.
- **Advantages**: Ensures that the project results are closer to customer needs through frequent feedback and adjustments, reduces waste, and increases project flexibility.

Hybrid Lifecycle:

- **Characteristics**: Combines features of both predictive and adaptive lifecycles. Some parts of the project are planned in detail using predictive methods, while other parts are flexibly adjusted using adaptive methods. The specific implementation depends on the project's requirements and environment.
- **Applicability**: Suitable for projects with both clear long-term goals and a need to flexibly respond to short-term changes, such as large IT infrastructure projects or large organizational change projects across departments.
- **Advantages**: Utilizes the planning and control strengths of the predictive approach while addressing changes and uncertainties through the adaptive approach, thus comprehensively managing the different needs of the project.

Before Project Initiation

Use PGOA Principle To Create Business Plan—OBM

1. **Potential**
   - **Market Demand**: Assess if there is enough consumer need for the product or service.
   - **Technical Feasibility**: Determine if the technology required to implement the project is available.
   - **Resource Availability**: Check if there are sufficient funds, personnel, and materials to support the project.
   - **Competitive Analysis**: Understand if there are existing similar products or services in the market and the strengths and weaknesses of competitors (SWOT analyze).

2. **Goals**
   - **Short-term Goals**: For example, complete product development within 6 months.
   - **Long-term Goals**: For example, achieve a certain market share or revenue in three years.
   - **SMART Goals**: Ensure goals are Specific, Measurable, Achievable, Relevant, and Time-bound.

The goals should be aligned to the effort and time being invested.

3. **Options**
   - **Different Options**: List several feasible options, such as independent development, collaborative development, or outsourcing.
   - **Pros and Cons**: Analyze the advantages and disadvantages of each option and potential risks.
   - **Resource Requirements**: Determine the resources needed for each option.

4. **Action**
   - **Action Steps**: Outline specific steps and a timeline.
   - **Resource Allocation**: Allocate the necessary resources, such as funds and personnel.
   - **Responsibility Assignment**: Assign responsible parties for each task.
   - **Monitoring and Adjustment**: Set up regular check-ins and adjust the plan as needed.

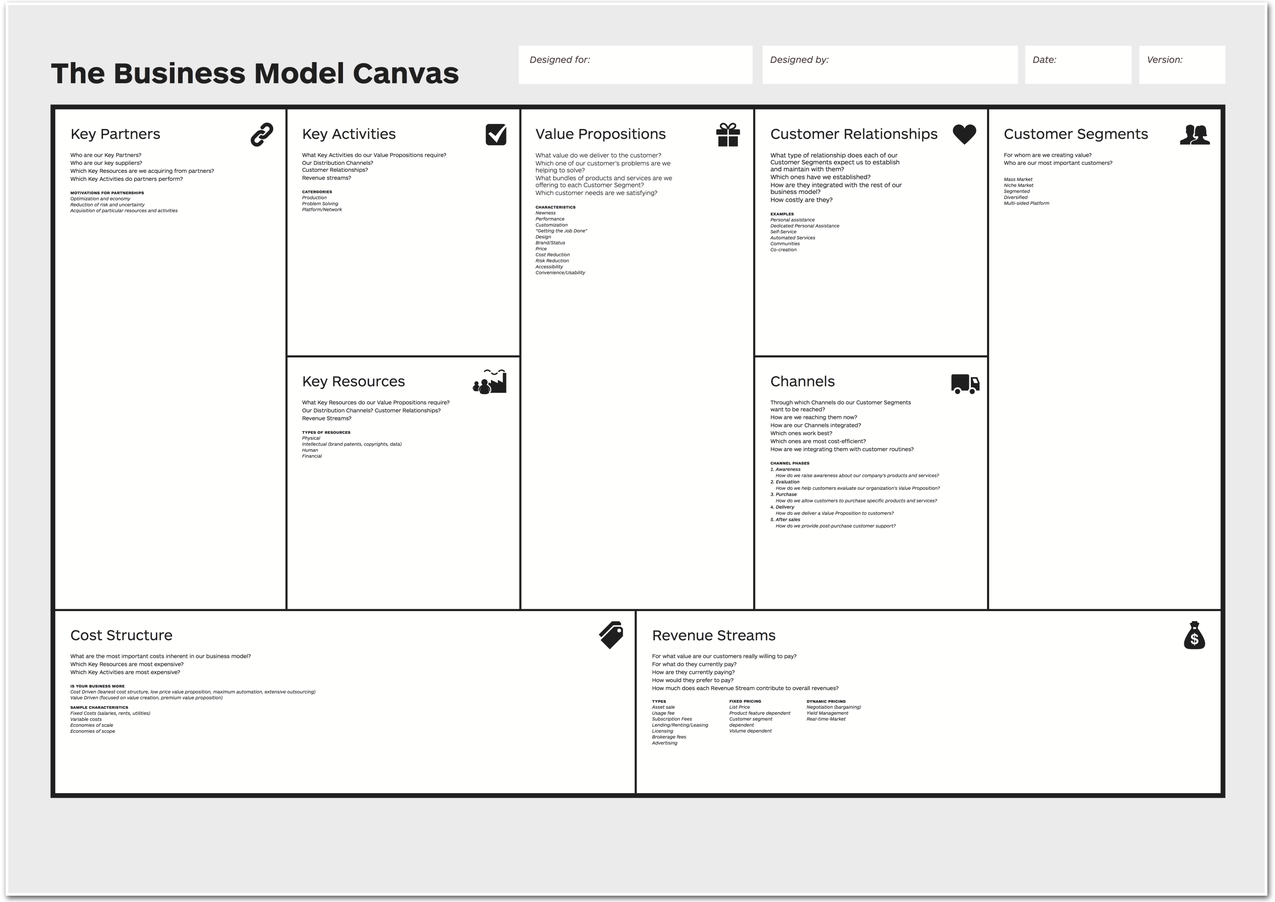
Benchmarks In IPD—$APPEALS / Recognize Opportunities—OBM

- Price—Reflects the price a customer is willing to pay for a satisfactory product
- Availability—How users obtain the product, enhancing the convenience and efficiency of the customer’s purchasing experience
- Packaging—Includes style, appearance, dimensions, color, packaging material quality, logistics transportation etc.
- Performance—Expectations for product functionality (how mach) and performance(how well).
- Ease of Use—Indicates the usability of the product, including installation, operation, maintenance, recycling, ergonomics etc.
- Assurances—Requirements for product reliability, safety, and quality.
- Lifecycle cost—Additional costs that customers incur during the use of the product.
- Social influences—Social acceptance；includes Customs and traditions, ethnic culture, environment, laws&regulations.

Business Model Canvas —A Strategic Management Tool For OBM

The Business Model Canvas is a strategic management tool that provides a visual chart with elements describing a company's value proposition, infrastructure, customers, and finances. It helps businesses to systematically understand, design, and differentiate their business models.

- **Customer Segments**: Defines the different groups of people or organizations an enterprise aims to reach and serve.
- **Value Propositions**: Describes the bundle of products and services that create value for a specific Customer Segment.
- **Channels**: Explains how a company communicates with and reaches its Customer Segments to deliver its Value Proposition.
- **Customer Relationships**: Describes the types of relationships a company establishes with specific Customer Segments.
- **Revenue Streams**: Represents the cash a company generates from each Customer Segment (costs must be subtracted from revenues to create earnings).
- **Key Resources**: Describes the most important assets required to make a business model work.
- **Key Activities**: Describes the most important things a company must do to make its business model work.
- **Key Partnerships**: Describes the network of suppliers and partners that make the business model work.
- **Cost Structure**: Describes all costs incurred to operate a business model.



Review The Framework Of The Potential Project —OEM

- Risks
- Revenue opportunity
- Overall feasibility assessment
- Resources(human&equipment)

SOW/SOR Review—OEM

The SOW is a formal document provided by the customer that defines the entire scope of the work involved for a producer, clarifies deliverables, and gives a timeline.

The statement of work should include:

- Deliverables
- project start-up date
- Project Volume
- Customer Requirements
- Critical Items/Key Characteristics

The details in the SOW are reviewed by both parties to ensure all customer requirements are understood and the suppliers selected have the capability to comply. Identified exceptions if applicable are resolved between both parties and SOW is revised accordingly.

Predictive Lifecycle In General

1. Initiating Phase

Objective: Determine the feasibility of the project and obtain formal approval to proceed.

Key Activities:

- **Project Charter**: Create and approve the project charter, outlining the project's purpose, objectives, scope, key stakeholders, budget, and timeline.
- **Identify Stakeholders**: Identify all project stakeholders and document their needs, expectations, and influence.

2. Planning Phase

Objective: Develop detailed plans for all aspects of the project to ensure it can be completed on time, within budget, and to the required quality standards.

Key Activities:

- **Scope Management Plan**: Define the project scope, including a detailed project scope statement, Work Breakdown Structure (WBS), and WBS dictionary.
- **Schedule Plan**: Develop the project schedule, including activity definition, activity sequencing, activity duration estimation, and schedule development.
- **Cost Management Plan**: Estimate project costs and develop the budget.
- **Quality Management Plan**: Define quality requirements and standards, and develop quality assurance and quality control plans.
- **Resource Management Plan**: Plan the necessary resources, including human resources, equipment, and materials.
- **Risk Management Plan**: Identify, analyze, and plan responses to project risks.
- **Communications Management Plan**: Develop strategies and plans for project communications.
- **Procurement Management Plan**: Determine procurement needs and strategies, and develop the procurement plan.
- **Stakeholder Management Plan**: Plan how to manage and engage project stakeholders.

3. Executing Phase

Objective: Execute the project activities as per the project plan to achieve the project objectives.

Key Activities:

- **Manage Project Team**: Assemble and manage the project team to ensure tasks are completed as planned.
- **Quality Assurance**: Implement the quality management plan to ensure the project meets quality standards.
- **Manage Communications**: Execute the communications management plan to ensure timely and accurate dissemination of project information.
- **Conduct Procurements**: Execute procurement activities as per the procurement plan and manage supplier relationships.
- **Manage Stakeholder Engagement**: Engage with stakeholders to ensure their participation and support.

4. Monitoring and Controlling Phase

Objective: Track the project's progress to ensure it is on track and make necessary adjustments.

Key Activities:

- **Monitor and Control Project Work**: Continuously monitor project progress and collect and analyze performance data.
- **Perform Integrated Change Control**: Process change requests, assess their impact, and approve or reject changes.
- **Validate and Control Scope**: Ensure project deliverables meet the scope statement and control scope changes.
- **Control Schedule**: Monitor the project schedule to ensure timely completion of tasks.
- **Control Costs**: Monitor project costs to ensure the project stays within budget.
- **Control Quality**: Implement quality control measures to ensure project deliverables meet quality requirements.
- **Monitor Risks**: Continuously monitor risks and implement risk response plans.

5. Closing Phase

Objective: Complete all project activities, formally close the project, and hand over project deliverables.

Key Activities:

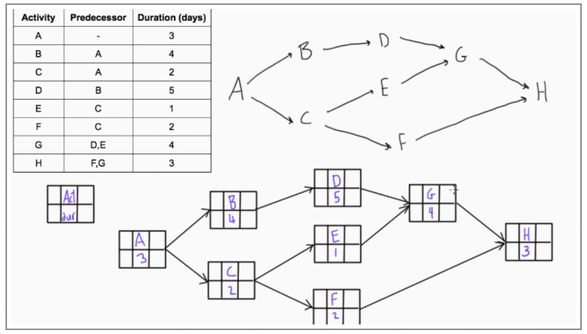
- **Close Project or Phase**: Confirm all project activities are completed, gather project documents, and conduct project reviews.
- **Close Procurements**: Finalize all procurement activities, ensure all contractual obligations are met, and close procurement contracts.
- **Archive Documents**: Organize and archive all project documents and records.
- **Project Review**: Conduct a project review to identify lessons learned and prepare a project summary report.

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work 4.4 Manage Project Knowledge	4.5 Monitor and Control Project Work 4.6 Perform Integrated Change Control	4.7 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Schedule Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Durations 6.5 Develop Schedule		6.6 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Manage Quality	8.3 Control Quality	
9. Project Resource Management		9.1 Plan Resource Management 9.2 Estimate Activity Resources	9.3 Acquire Resources 9.4 Develop Team 9.5 Manage Team	9.6 Control Resources	
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Monitor Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses	11.6 Implement Risk Responses	11.7 Monitor Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Engagement	13.3 Manage Stakeholder Engagement	13.4 Monitor Stakeholder Engagement	

Table 1-4 (Guide). Project Management Process Group and Knowledge Area Mapping

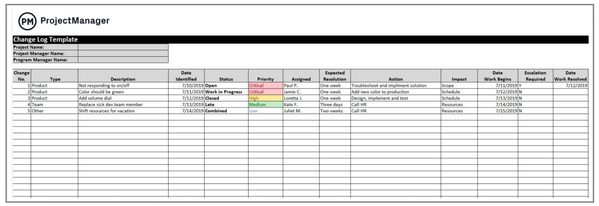
Tools and Techniques

- **Work Breakdown Structure (WBS)**: Breaking down the project into manageable tasks and subtasks to better organize and control the project.
- **Network Diagram**: Including Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) to determine the sequence and dependencies of tasks in the project, as well as identifying the critical path and early completion time.
- **Milestone Chart**: Identifying important milestones and key points in the project to track its progress. (gate review)
- **Project Schedule (Gantt Chart)**: Used to track the project's progress, including start and finish times of tasks, and completion percentages.
- **Risk Register**: Recording identified risks in the project, including risk descriptions, impacts, probability, and response plans.
- **Decision Tree Analysis**: Used to evaluate the potential outcomes and value of different decisions in the project to help make the best decision (risk management).
- **Quality Measurement Tools**: Used to measure the quality of project deliverables, including checklists, flowcharts, and control charts (statical process control chart).
- **Cost Estimation Techniques**: Including expert judgment, analogy estimation, parametric estimation, and three-point estimation methods to estimate project costs.
- **Performance Measurement and Metrics**: Including Schedule Performance Index (SPI), Cost Performance Index (CPI), and Risk Performance Index (RPI) to assess project performance.
- **Change Management Tools**: Including change control boards and change request processes to manage changes in the project and ensure effective implementation of changes.
- **Resource Allocation Chart**: Used to identify and track the allocation of various resources (such as personnel, materials, and equipment) in the project.



Activity	Predecessor	Duration (days)
A	-	3
B	A	4
C	A	2
D	B	5
E	C	1
F	C	2
G	D,E	4
H	F,G	3

PDM diagram



ProjectManager

Change Log Template

Project Name:
Project Manager Name:
Program Manager Name:

Change No.	Type	Description	Date Identified	Status	Priority	Assigned	Expected Resolution	Action	Impact	Date Work Begins	Escalation Required	Date Work Resolved
1	Product	Not responding to on/off	7/10/2019	Open	Critical	Paul P.	One week	Troubleshoot and implement solution	Scope	7/11/2019		7/12/2019
2	Product	Color should be green	7/11/2019	Work in Progress	Critical	Jamie C.	One week	Add new color to production	Schedule	7/11/2019	N	
3	Product	Add volume dial	7/11/2019	Closed	High	Loretta J.	One week	Design, implement and test	Schedule	7/11/2019	N	
4	Team	Replace sick dev team member	7/13/2019	Late	Medium	Kate F.	Three days	Call HR	Resources	7/14/2019	N	
5	Other	Shift resources for vacation	7/14/2019	Combined	Low	Juliet M.	Two weeks	Call HR	Resources	7/15/2019	N	

Change Control Board

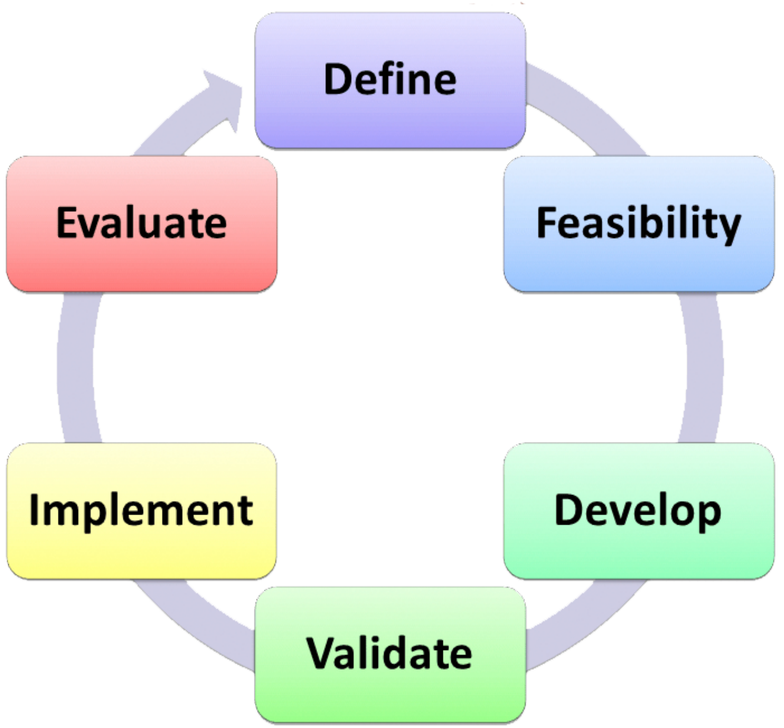
Introduction to APQP

Advanced Product Quality Planning

PM In Automotive Industry

What is APQP?

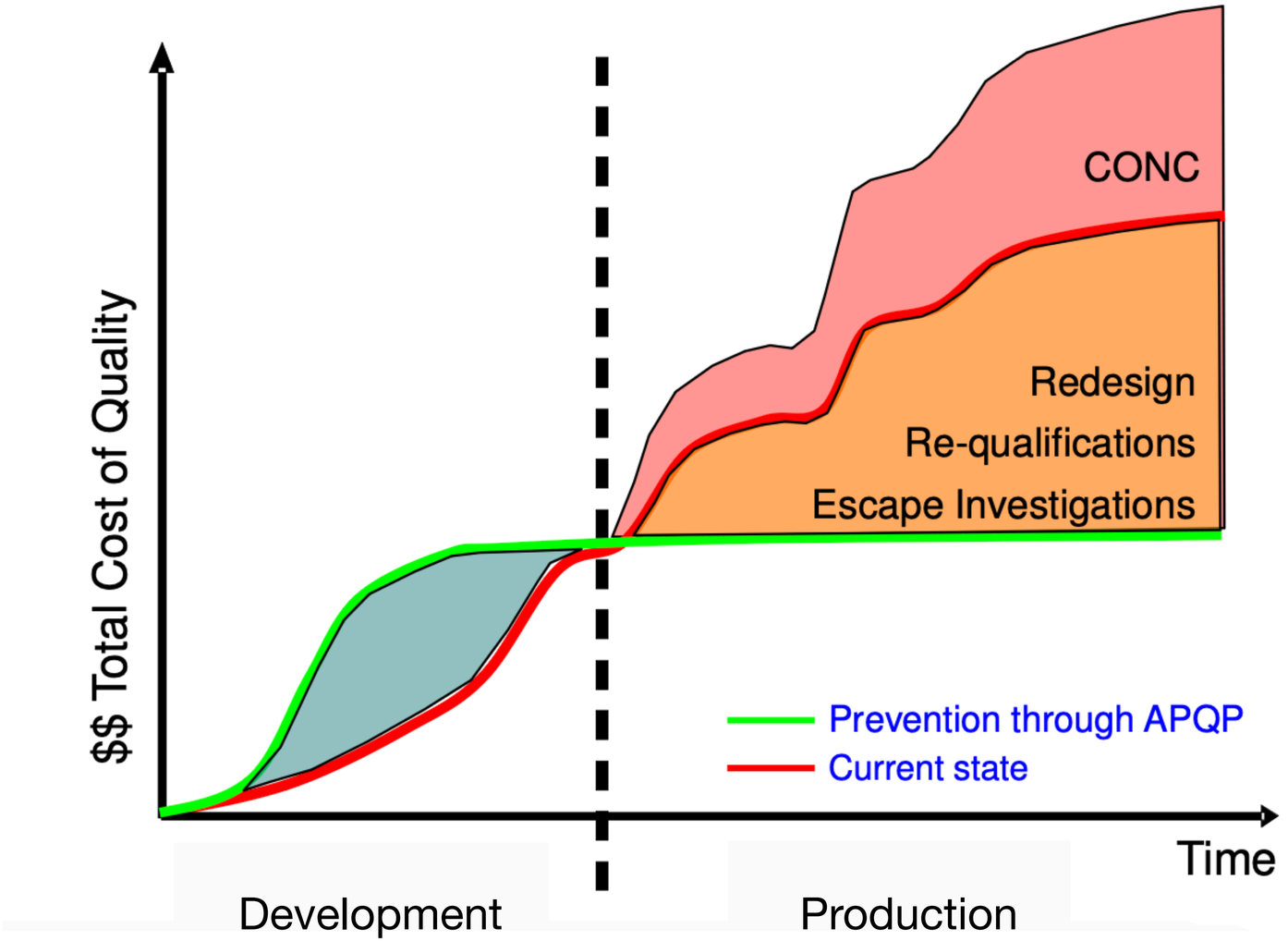
- Advanced Product Quality Planning method to assure that a product satisfies the customer (both internal and external).
- The goal of APQP is to facilitate communication with everyone(CFT) and to assure that all required steps are completed on time
- APQP ensures the Voice of the Customer is clearly understood, translated into requirements, technical specifications and special characteristics. The product or process benefits are designed in through prevention.
- AIAG (Automotive Industry Action Group) APQP phases are Planning, Product Design, Process Design, Validation, Production. (Similar to PDCA or NPI Phases; Traditional Predictive Project Management Method)



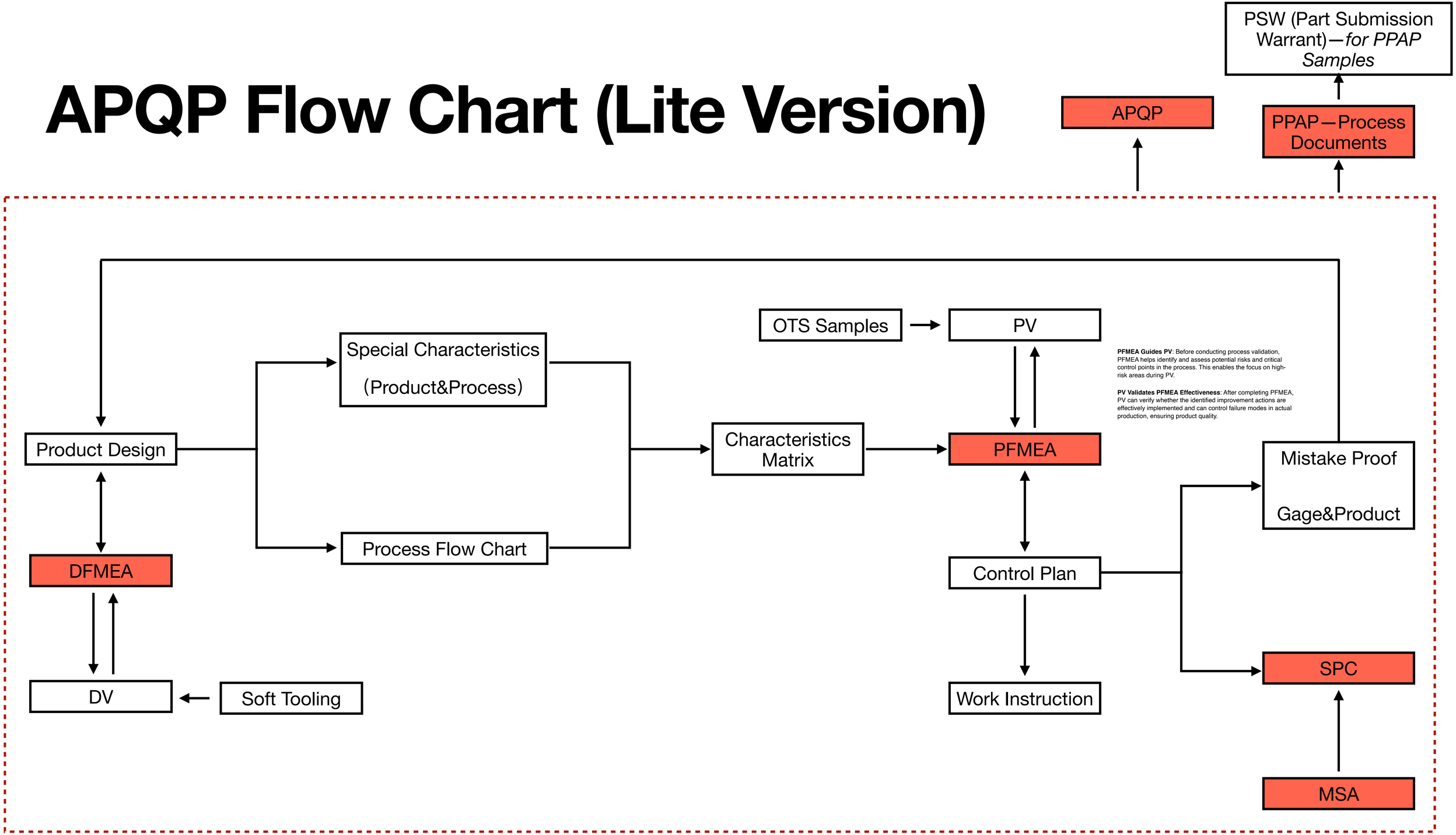
New Product Introduction Phases

APQP Benefits

- Robust and reliable designs
- Reduced process variation
- Enhanced confidence in supplier's capabilities
- Better controlled process changes
- Defect free launches
- Improved Customer satisfaction
- Improved Delivery and Service
- Maximum ROI (Return on Investment)
- Minimum Waste
- Minimum CONC (Cost of Non Conformance)



APQP Flow Chart (Lite Version)



1. Plan and Define Program

Assure that customer needs and expectations are clearly understood

INPUTS

- Voice of the Customer/ Regulation Requirement
- Business Plan/Marketing Strategy
- Product/Process Benchmark Data
- Product Reliability Studies (Resistance; Working Condition)
- Product/Process Assumptions (Concepts for New Product/ Process Features and Adoption of New Materials and Technologies)

New Product Development Charter

Cost analysis

- QFD (quality&function deployment)
- Product Feasibility Assessment Report (project review for voc; regulations; costs; production capacity; processes; equipment; material characteristics; testing methods; procurement etc.)

OUTPUTS

- Design Goals (*appearance ; function ; performance ; structure ; eco-friendly etc.*)
- Reliability (*lifespan ; failure rate*) & Quality goals (*PPM ; CPK etc.*)
- CONC* targets
- Preliminary Bill of Materials
- Preliminary Process Flow Chart
- Preliminary list of Special Product and Process Characteristics
- Product Assurance Plan (Risks in Whole Process and Preliminary Control Plan)
- Management Support

2. Product Design and Development

Develop design into a near final form. Prototype and feasibility studies

INPUTS

- Design Goals
- Reliability & Quality goals
- CONC* targets
- Preliminary Bill of Materials
- Preliminary Process Flow Chart
- Preliminary list of Special Product and Process Characteristics
- Product Assurance Plan
- Management Support

OUTPUTS

Design Outputs

The DFMEA determines "What" and the DVP&R defines "How"

Design features, details, tolerances and refinement of special characteristics are all reviewed in a formal Design Review. Design verification through prototypes and testing are also part of this section.

- Design For Manufacturability and Assembly
- Design Failure Mode and Effects Analysis (DFMEA)
- Product and Process Characteristics
- Prototype Build – Control plan (optional)
- Design Verification and Report (DVP&R in prototype stage)
- Design Reviews
- Engineering Drawings (2D/3D)
- Material Specifications
- Drawing and Specification Changes

Verify the design output to confirm that it meets the design input and customer requirements.

APQP Outputs

- New Equipment, Tooling and Facilities Requirements
- Gages/Testing Equipment Requirements
- Team Feasibility Commitment
- Management Support

3. Process Design and Development

Develop a manufacturing system and its related control plans to achieve quality products.

INPUTS

- Design For Manufacturability and Assembly
- Design Failure Mode and Effects Analysis (DFMEA)
- Product and Process Characteristics
- Prototype Build – Control plan (optional)
- Design Verification and Report (DVP&R in prototype stage)
- Design Reviews
- Engineering Drawings (2D/3D)
- Material Specifications
- Drawing and Specification Changes
- New Equipment, Tooling and Facilities Requirements
- Gages/Testing Equipment Requirements
- Team Feasibility Commitment
- Management Support

Off Tool Sample (OTS)

Attention :DFMEA should be frozen before mold machining

OUTPUTS

In this section, manufacturing techniques and measurement methods that will be used to bring the design engineer's vision into reality.

- Process Flow Chart
- Characteristics Matrix
- Process Failure Mode and Effects Analysis (PFMEA)
- Pre-Launch Control Plan
- Process Instructions (Work Instruction)
- Measurement Systems Analysis Plan (MSA)
- Preliminary Process Capability Study Plan (SPC– ppk)
- Packaging Specifications
- Packaging Standards
- Floor Plan Layout
- Product/Process Quality System Review
- Management Support

The validation process for Off-Tool Samples (OTS) is crucial to ensure that the final mass-produced products meet quality and design specifications. The following checks and verifications are typically performed on OTS samples:

1. **Visual Inspection**:
   - **Surface Quality**: Check for surface defects such as scratches, bubbles, dents, and burrs.
   - **Color and Consistency**: Ensure the color is uniform and matches the design specifications.
   - **Markings and Labels**: Verify that all markings and labels are accurate and properly placed.
2. **Dimensional and Geometric Tolerance Checks**:
   - **Critical Dimension Measurements**: Use precision measuring tools (e.g., calipers, coordinate measuring machines) to verify critical dimensions against drawings and tolerance specifications.
   - **Geometric Features**: Check shape, position, flatness, straightness, and other geometric features.
3. **Functional Validation**:
   - **Operational Tests**: Verify the sample's functionality and operational performance to ensure it works as intended.
   - **Load Testing**: Apply actual use loads to check if the sample can withstand and operate under expected conditions.
   - **System Integration**: Ensure the sample fits and works correctly within the overall system.
4. **Material and Process Validation**:
   - **Material Composition and Properties**: Perform chemical analysis and mechanical property tests to ensure the material meets the specified requirements.
   - **Manufacturing Process Consistency**: Check that the sample was produced following the specified process parameters and workflows, verifying process stability and consistency.
5. **Environmental and Durability Testing**:
   - **Temperature Cycling Tests**: Evaluate the sample's performance under extreme temperature conditions.
   - **Humidity Tests**: Assess the sample's resistance to high humidity conditions.
   - **Vibration and Shock Tests**: Simulate transportation and usage vibrations and shocks to evaluate durability and reliability.
6. **Performance Testing**:
   - **Mechanical Performance Tests**: Tests such as tensile, compression, and bending to evaluate the sample's mechanical properties.
   - **Electrical Performance Tests** (if applicable): Tests such as resistance, voltage, and current to evaluate the sample's electrical properties.
7. **Assembly and Fit Validation**:
   - **Assembly Tests**: Verify the sample's fit and compatibility during actual assembly processes to ensure no interference or misfit.
   - **Fit Tests**: Check the sample's compatibility with other components to ensure proper assembly and overall performance.
8. **Customer and Internal Audits**:
   - **Customer Audits**: Involve customers in the audit process to ensure the sample meets their requirements.
   - **Internal Quality Audits**: Conduct comprehensive internal audits by the quality team to ensure compliance with internal quality standards.
9. **Regulatory and Standards Compliance**:
   - **Regulatory Testing**: Verify the sample's compliance with relevant regulations and standards, such as safety and environmental regulations.
   - **Certification Testing**: Perform necessary certification tests to obtain required certifications.

By performing these validations, OTS samples can ensure they meet all design and quality requirements, providing a reliable foundation for mass production.

4. Product and Process Validation

Validate manufacturing process through production trial run. the control plan and process flow chart are effective.

INPUTS

- Process Flow Chart
- Characteristics Matrix
- Process Failure Mode and Effects Analysis (PFMEA)
- Pre-Launch Control Plan
- Process Instructions (Work Instruction)
- Measurement Systems Analysis Plan (MSA)
- Preliminary Process Capability Study Plan (SPC– ppk)
- Packaging Specifications
- Packaging Standards
- Floor Plan Layout
- Product/Process Quality System Review
- Management Support

Attention :PFMEA should be frozen before PPAP

OUTPUTS

- Measurement Systems Evaluation (Gage R&R)
- Production Trial Run
- Preliminary Process Capability Study
- Production Validation Testing (PVP&R)
- Production Control Plan
- Packaging Evaluation
- Production Part Approval (PPAP process)
- Quality Planning Sign-Off - formal
- Management Support

5.Feedback, Assessment, Corrective

Evaluate outputs, effectiveness of the product quality planning efforts.

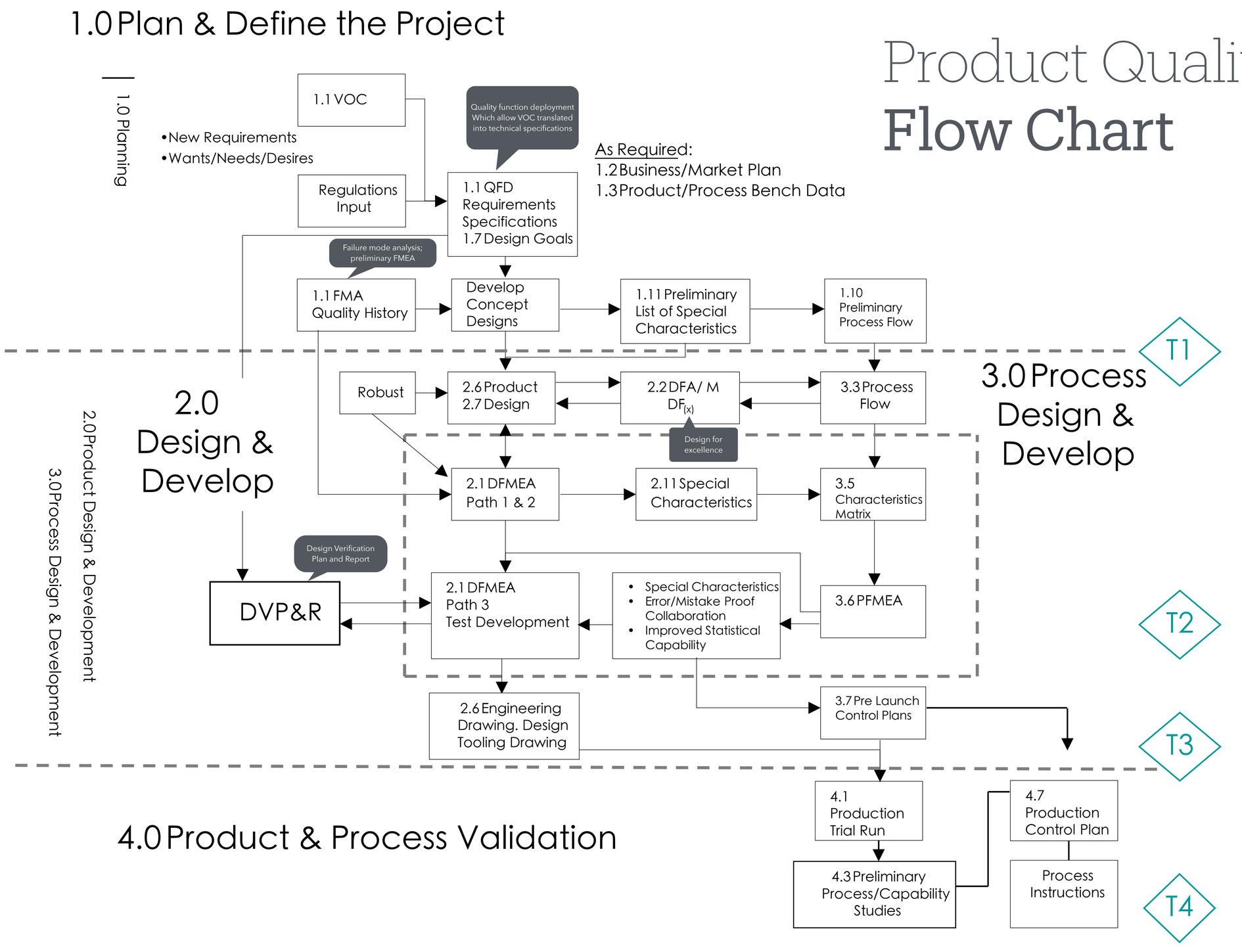
INPUTS

- Production Trial Run
- Measurement Systems Evaluation
- Preliminary Process Capability Study
- Production Part Approval
- Production Validation Testing
- Packaging Evaluation
- Production Control Plan
- Quality Planning Sign-Off & Management Support

OUTPUTS

- Reduced Variation
- Improved Customer Satisfaction
- Improved Delivery and Service
- Effective use of best practice, lessons learned
- Maximum ROI
- Minimum Waste
- Minimum CONC

Product Quality Plan
Flow Chart



Process Flow Chart

In Process Design and Development

- **What?** Process Flow Diagram is a visual diagram of the entire process from receiving through shipping, including outside processes and services

- **Why?** To help us “see” the real process. Process maps can be used to understand the following characteristics of a process: *1.Set-by-step process linkage 2.Offline activities (measurement, inspection, handling) 3.Rework, scrap*

- **When?** When need to understand how a process is done ; Prior to completing the PFMEA

- **Who?** Manufacturing engineers ; Line operators ; Line supervisors ; Maintenance technicians (CFT)

Inputs to Mapping: Brainstorming ; Operator manuals ; Engineering specifications ; Operator experience ; 6Ms of Production (man, machine, material, method, mother nature and measurement)

Outputs to: PFEMA ; Control Plan ; Capability Studies ; MSA

Process Flow Chart

Crucial Points

- Process Flow must identify each step in the process
- Should include abnormal handling processes (scrap ; rework…..)
- Process Flow must include all phases of the process:
  - *Receiving of raw materials*
  - *Part manufacturing*
  - *Offline inspections and checks*
  - *Assembly*
  - *Testing*
  - *packaging*
  - *Transportation*

PROCESS FMEA

In Process Design and Development

- **What?** A technique which analyzes processes that can impact quality. A tool used to identify and prioritize risk areas (such as human error) and their mitigation plans.
- **Why?** Help us to monitor critical process parameters and develop effective process control plans.
- **When?** After completion of the process flow diagram, prior to tooling for production
- **Who?** A cross-functional team (CFT)
- **How?** See next slide

ATTENTION

PFMEA is conducted when the following occurs in the organization:

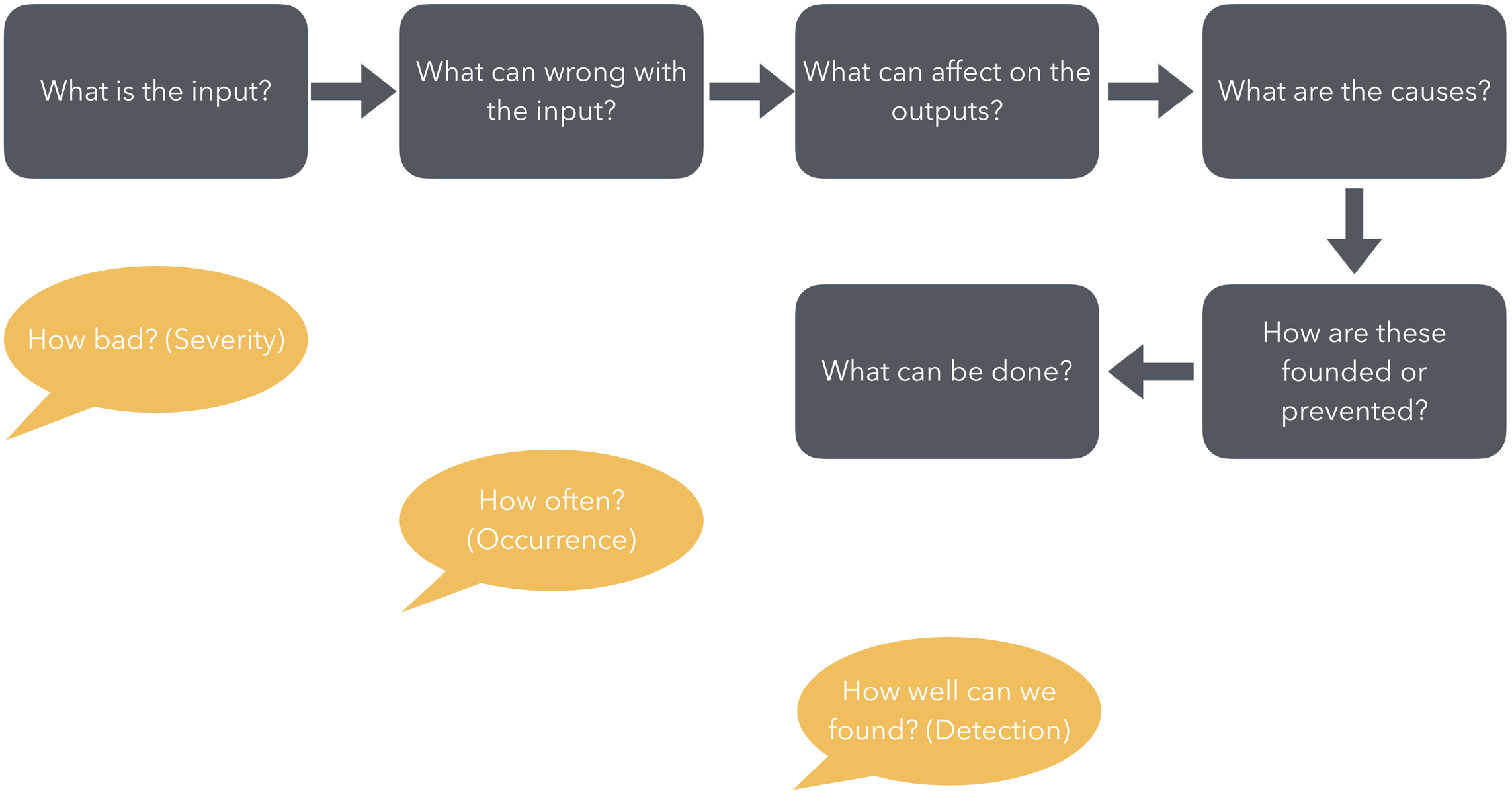
- New changes are made on existing processes
- Introduction to new technology ,equipment, or process steps
- Moving a process to a new facility, or department.

The 7 Steps of PFMEA

1. Process Review (for each Process Input, determine the ways in which the Process Step can go wrong)
2. Identify Potential Failure Modes
3. List Potential Failure Effects & Assign **Severity** Score
4. Determine Potential Causes & Assign **Occurrence** Rating
5. Determine Current Process Controls & Assign **Detection** Rating
6. Calculate RPN & Create Actions
7. Re-Calculate RPN （Risk priority number）

In general, reducing the Occurrence
Is preferable to improving the Detection

**RPN = S(severity) × P(probability) × D(detection)*


What is the input?
What can wrong with the input?
What can affect on the outputs?
What are the causes?
How are these founded or prevented?
What can be done?
How bad? (Severity)
How often? (Occurrence)
How well can we found? (Detection)

PROCESS FMEA

Crucial Points

- Verify there is a system for prioritizing risk of failure such as high RPN numbers
- Make sure that high RPN process concerns are carried over into the control plan
- Make sure that all critical failure modes are addressed:
  - *Safety*
  - *Form , function*
  - *Material concerns etc.*

Process Control Plan (PCP)

ATTENTION：
It is a living documents that need to be changed in step with manufacturing

In Process Design and Development

- **What?** It is a document describing the process step, the process's quality control items, responding control methods, and reaction plans. In other words, it is a plan to control production/ service processes to assure the product, service, and process requirements are met.

- **Why?** The Control Plan improves product quality by identifying the sources of variation in a process and establishing controls to monitor them. when scrap and reworks are reduced, throughput of the process is inherently improved.

- **When?** After completion of the process flow diagram/pFMEA. At Prototype, Pre-launch and Production (implementation of new process; process change)

- **Who?** The Control Plan should be developed by a Cross Functional Team that has an understanding of the process being controlled or improved.

- **How?** See next slide.

How to Develop a Control Plan?

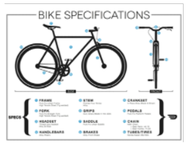
Control Plan Inputs

Customer Needs

- Critical Specifications
- Purchase Order
- Contract

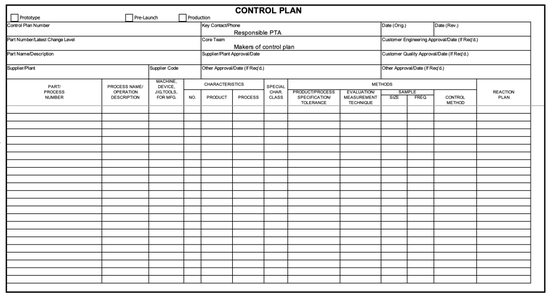
Team

- Design&Manufacturing Inputs



Spec's

- DFEMA&PFEMA



CONTROL PLAN

Prototype | Pre-Launch | Production

Control Plan Number			Key Contact/Phone					Date (Orig.)		Date (Rev.)		
			Responsible PTA									
Part Number/Latest Change Level			Core Team					Customer Engineering Approval/Date (If Req'd.)				
			Makers of control plan									
Part Name/Description			Supplier/Plant Approval/Date					Customer Quality Approval/Date (If Req'd.)				
Supplier/Plant		Supplier Code	Other Approval/Date (If Req'd.)					Other Approval/Date (If Req'd.)				
PART/ PROCESS NUMBER	PROCESS NAME/ OPERATION DESCRIPTION	MACHINE, DEVICE, JIG/TOOLS, FOR MFG.	CHARACTERISTICS			SPECIAL CHAR. CLASS	METHODS					REACTION PLAN
			NO.	PRODUCT	PROCESS		PRODUCT/PROCESS SPECIFICATION/ TOLERANCE	EVALUATION/ MEASUREMENT TECHNIQUE	SAMPLE SIZE	SAMPLE FREQ.	CONTROL METHOD	

Concretely Inputs

- Design Failure Mode and Effects Analysis (DFMEA)
- Process Failure Mode and Effects Analysis (PFMEA)
- Special Characteristics Matrix
- Lessons Learned from similar parts
- Design Reviews
- Team knowledge about the process
- Field or warranty issues

CONTROL PLAN

VAZ101-23 Rev: 4 Date: 2/1/2020

Part #: 987-00	Drawing Rev, Date: 1, 2 / 11-19
Part Name / Description: Leg, Support, and Armrest Assembly	Mfg Approval: Joe Linguadoca Eng Approval: Ed Stumpek

REF #	PROCESS NAME/ OPERATION DESCRIPTION	SAFETY OR CTQ?	SPECIFICATIONS AND CONTROLS				REACTION PLAN
			SPECIFICATION / TOLERANCE	EVALUATION / MEASUREMENT	SAMPLING REQUIREMENT	CONTROL METHOD	
1	Place leg, support, and armrest in assembly fixture	N/A	Parts placed properly in fixture per dwg 987-00	Visual - parts oriented correctly (reference drawing 987-00)	Once per shift	Verify that fixture 1270 is being used and that operator has been signed off	Quarrantine and 100% inspect all product built on shift
2	Drive two screws to secure side support	S	Screw heads .1 mm sub-flush, +/- .1mm	Flush gage 650-B	Changeover and once per hour	Red/yellow/green indicators on gage dial	Quarrantine and 100% product since last inspection
		N/A	Seating torque between 10 in-lb and 13 in-lb	Automatically monitored - alarm will sound if torque is out of range	N/A	100% automatic monitoring	If torque alarm sounds, stop production, verify proper screws, check pilot hole diameter. If correct, contact maintenance and engineering.

1. Reference Number / Rev	This is for the control plan itself – control plans can change, independent of drawing specifications.
2. Revision Date	Revision date for the control plan itself.
3. Part Number	Engineering drawing or part number that contains the relevant specifications.
4. Approval Blocks	At a minimum, engineering and manufacturing responsible parties should sign off on the control plan.
5. Ref #	Normally links back to the process step # in the process flow chart.
6. Process Name	Note what is happening during this process step.
7. Safety or CTQ?	Keep any special notations in this column relative to criticality. Safety or critical-to-quality specifications are the top priority in any control plan.

8. Specification / Tolerance	Note the engineering specification, as stated on the drawing, along with the tolerance.
9. Evaluation / Measurement	This is the method for measuring or otherwise evaluating the product/process to ensure that the specification is met.
10. Sampling Requirement	How frequently the measurement will take place. Sampling requirements are usually time based or quantity based .
11. Control Method	This column summarizes how the process is controlled, in order to deliver an in-specification result for the given spec.

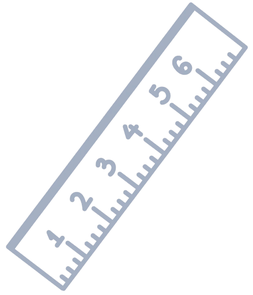
Process Control Plan (PCP)

Crucial Points

- Use process flow diagram and PFMEA to build the control plan; keep them aligned
- Controls should be effective. Keep it simple.
- Upstream controls are better than downstream controls.
- Good control plans address:
  - All testing requirements - dimensional, material, and performance
  - All product and process characteristics at every step throughout the process
- The control method should be based on an effective analysis of the process (Such as SPC, Error Proofing, Inspection, etc.)

Measurement System Analysis

In Process Validation



- **What?** An MSA is a statistical tool used to determine if a measurement system is capable of precise measurement. Applicable to both attribute data and variable data.

- **Why?** To determine how much error is in the measurement due to the measurement process itself; Quantifies the variability added by the measurement system

- **When?** On the critical inputs and outputs prior to collecting data for analysis. For any new or modified process in order to ensure the quality of the data.

- **Who?** Everyone that measures and makes decisions about these measurements should be involved in the MSA.

- **How?** See slide “Gage” R&R Study

Attribute data can show if something failed or not, while **variable data** can show how much it failed by

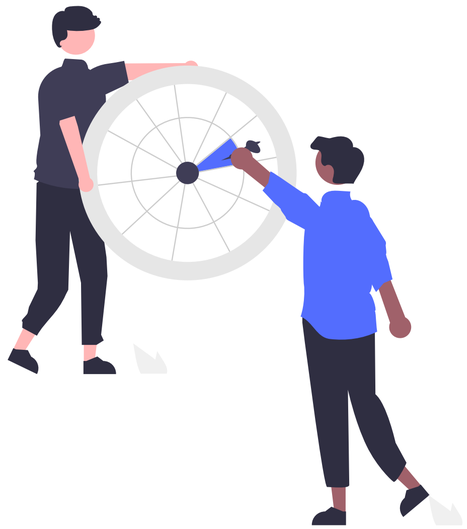
Total Variation= Variation of Component + Variation of Measurement

Variation of Measurement=Precision + Accuracy

Random Error-> **Precision = Repeatability (Equipment) + Reproducibility (Human) +Resolution**

System Error-> **Accuracy = Bias + Stability + Linearity**

Gage R&R



Element of Precision / Random Error

Resolution

- Error in Resolution
  The inability to detect small changes.
- Possible Cause
  Wrong measurement device selected.
  Divisions on scale not fine enough to detect changes.

Repeatability

- Error in Repeatability
  The inability to get the same answer from repeated measurements made of the same item under absolutely identical conditions.
- Possible Cause
  Lack of standard operating procedures (SOP), lack of training, measuring system variability.

Reproducibility

- Error in Reproducibility
  The inability to get the same answer from repeated measurements made under various conditions from different inspectors.
- Possible Cause
  Lack of SOP, lack of training.

Gage R&R Study

Estimate of Measurement System Repeatability and Reproducibility

Detailed Example

Suppose a factory needs to evaluate the Gage R&R of a system measuring the length of a part. The steps would be as follows:

1. **Select Samples and Operators**:
   - Choose 10 parts as samples.
   - Select 3 operators.
2. **Measurement and Data Recording**:
   - Each part is measured 2 times by each operator, resulting in a total of 60 data points.
3. **Data Analysis (using statistical software like Minitab, JMP, or Excel)**:
   - Input the measurement data.
   - Choose an appropriate Gage R&R analysis method (typically the ANOVA method).
   - The software calculates and outputs the variance components, total variation, repeatability, and reproducibility.
4. **Interpret Results**:
   - Check if the repeatability and reproducibility are within acceptable ranges (generally, less than 10% of total variation is considered excellent, 10%-30% is acceptable, and more than 30% is unacceptable).

By conducting such an analysis, the reliability of the measurement system can be confirmed, and if necessary, steps can be taken to improve the measurement process or equipment to ensure product quality.

Statical Process Control (SPC)

In Process Validation

- **What?** Statistical Process Control, is a method used to monitor and control manufacturing processes to ensure they operate at their full potential and produce conforming products. The main goal of SPC is to maintain process stability and keep variability within acceptable limits.

- **Why?** The SPC process is implemented to move a company from detection based to prevention based quality controls.By monitoring the performance of a process in real time the operator can detect trends or changes in the process before they result in non-conforming product and scrap.

- **When?** Prior to SPC implementation, the key or critical characteristics of the design or process should be identified by a Cross Functional Team (CFT) during a review or Design Failure Mode and Effects Analysis (DFMEA) exercise.

- **Who?** Quality Control/Quality Assurance Teams, which include Production Operators responsible for taking regular measurements and recording data, and Process Engineers who analyze SPC data to identify trends, determine causes of variation, and find opportunities for process improvement etc.

- **How?** See next slide.

Process Capability Primer

- **Mean (Average)**: The mean is the average of all the data points. It is calculated by summing up all the values and dividing by the number of values.

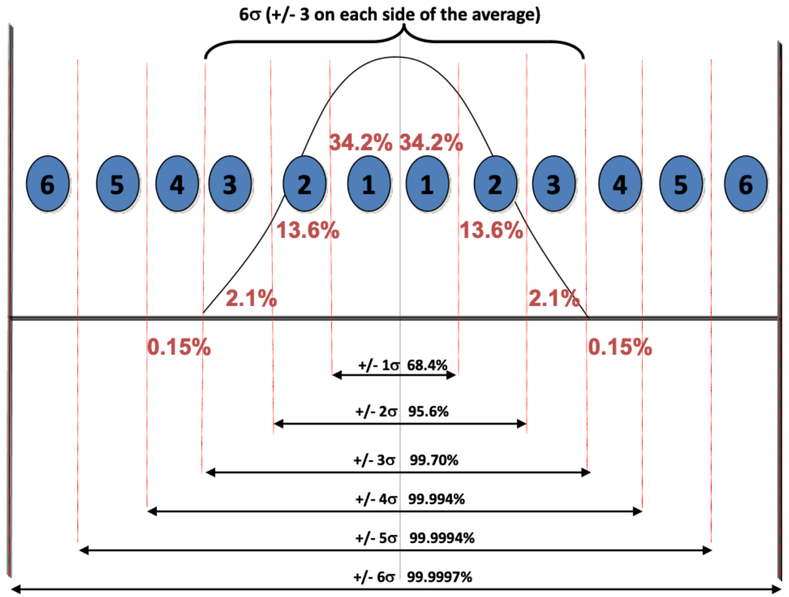
$$\text{Mean}(\mu) = \frac{\sum_{i=1}^{N} x_i}{N}$$

- **Standard Deviation**: Standard deviation is the square root of the variance. It provides a measure of the average distance of each data point from the mean(**Deviation)**.

$$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}} \qquad \text{Deviation} = x_i - \mu$$

Lower Spec Limit(LSL)

Upper Spec Limit (USL)



In an ideal scenario, the dimensional deviations of a batch of parts follow a normal distribution.

Six Sigma is a methodology that aims to achieve near perfection in process performance, limiting defects to 3.4 per million opportunities (DPMO).

- **Cp (Process Capability Index) /Cpk (Process Capability Index, Adjusted for Centering)**: Also called "short term" capability which is used to reliably determine if a process is yielding good initial results by taking a representative sample size.

  CP reflects the ratio of the specification width to the process width. If CP is greater than 1, it indicates a capable process. **CPK** accounts for the centering of the process relative to the specification limits. CPK reflects the capability of the process considering both the variability and the mean. A CPK value greater than 1 indicates a capable and centered process.

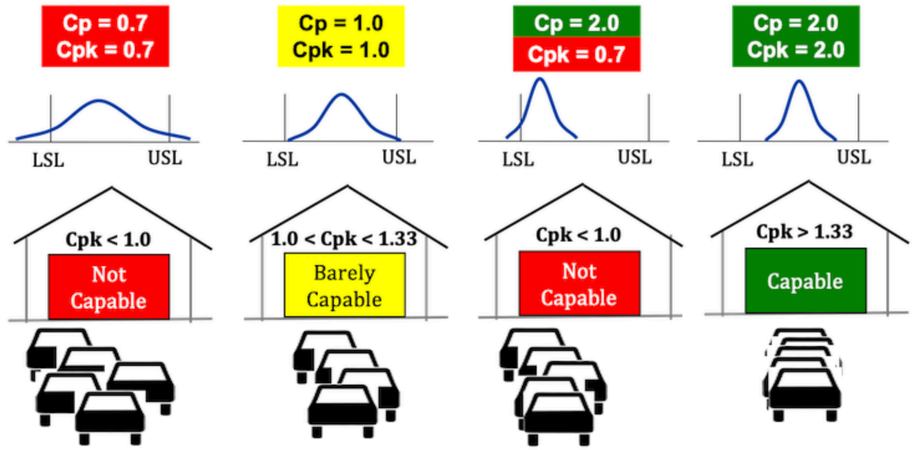
- **Pp/Ppk**: Also known as "long term" process capability. The key difference is that there is much more data on hand for Pp/Ppk. AIAG notes "90 shifts, 90 days"

$$CP = \frac{USL - LSL}{6\sigma} \qquad CPK = \min\left(\frac{USL - \mu}{3\sigma}, \frac{\mu - LSL}{3\sigma}\right)$$

The mean of the entire process.

$$PP = \frac{USL - LSL}{6\sigma_{\text{overall}}} \qquad PPK = \min\left(\frac{USL - \mu_{\text{overall}}}{3\sigma_{\text{overall}}}, \frac{\mu_{\text{overall}} - LSL}{3\sigma_{\text{overall}}}\right)$$

The standard deviation of the entire process.



SPC High Level Guidelines

1. SPC applies to both variables and attributes. It is a graph-based statistical method to analyze and control a process

2. First step is to insure MSA effectiveness; whether for variables or attributes

3. For variables, must insure that the process is capable FIRST, prior to establishing a control chart (Cpk >= 1.33)

4. Determine any key patterns that are meaningful to your process and train to those conditions. These typically include: Shifts, Trends, Points outside of the limits

5. After that, it’s a go/no go chart. The graphs help you to know when the processes change

PPAP—Product Part Approval Process

- **What?** PPAP is used to ensure that a supplier's production process can consistently produce parts that meet the customer's engineering specifications and quality requirements. It involves a series of steps, documentation, and sample submissions that validate the manufacturing process and product quality.

- **Why?** Provide evidence that all customer engineering design record and specification requirements are properly understood by the organization;To demonstrate that the manufacturing process has the potential to produce product that consistently meets all requirements during an actual production run at the quoted production rate.

- **When?** New Part Introduction;Engineering Changes;Supplier Change;Relocation of Manufacturing;Tooling Changes; Addressing issues found in previous production runs;Change in Manufacturing Process;Exceeding Production Quantities;Customer Requirements

- **Who?** Supplier Segment:QA (preparing and submitting the PPAP documentation) / Engineering (DV;PV;Design Modification) /Production Team (Implement of CP). Customer Segment:QA(reviewing and approving the PPAP submission.)/SQE(Coordinator)

PPAP Submission Levels

Requirement	Level				
	1	2	3	4	5
1. Part Submission Warrant	S	S	S	AR	S
2. Design Record & Bubbled Print(s)	NR	S	S	AR	S
3. Approved Engineering Change Documentation	NR	NR	S	AR	AR
4. Customer Engineering Approvals	NR	NR	NR	NR	NR
5. Desgin FMEA	NR	NR	AR	AR	AR
6. Process Flow Diagrams	NR	NR	S	AR	S
7. Process FMEA	NR	NR	S	AR	S
8. Control Plan	NR	NR	S	AR	S
9. Measurement System Analysis (MSA)	NR	NR	S	AR	S
10. Dimensional Results	NR	AR	S	AR	S
11. Material, Performance Test Results	NR	AR	S	AR	S
12. Initial Process Study (Cpk) *Capability Studies*	NR	NR	S	AR	S
13. Qualified Laboratory Documentation	NR	NR	S	AR	S
14. Appearance Approval Report	AR	AR	AR	AR	AR
15. Sample Product Parts	NR	AR	S	AR	S
16. Master Samples	NR	NR	NR	NR	R
17. Checking Aids	NR	NR	R	AR	R
18. Customer Specific Requirements	AR	AR	AR	AR	AR
18a. Tooling Information Form	NR	NR	S	AR	S
18b. Packaging Form	NR	NR	S	AR	S
18c Inspection Plan (ASC Only)	NR	IA	IA	IA	IA
18d. Specification Deviation Form	NR	IA	IA	IA	IA
18e. Supplier PPAP Checklist	S	S	S	S	S

S = Supplier **MUST** submit and retain a copy of records or documetantion items
R = Supplier **MUST** retain and make available to customer upon request

Symbol Key	
S	Submit
NR	Not Reuired
AR	As Requested
IA	If Applicable
R	Retain

Level 1	**Warrant Only** and Appearance Approval Report as requested. Applied to: Non-critical parts, Non-critical raw/bulk material or catalog/commodity parts for electrical applications and recertification of existing parts previously approved at levels 3, 4 or 5.
Level 2	**Warrant with product samples and limited supporting data.** Applied to: Critical bulk products such as Paint/Resin/Chemicals, critical fasteners, simple material changes, simple revision level only changes or simple print updates not impacting form-fit-function. This level can also be applied to low risk parts within a product family.
Level 3	**Default Submission Level:** Warrant with product samples and complete supporting data. Applied to: New parts, changes affecting form-fit-function, reliability or performance. All products resourced to new suppliers, serial production parts, and existing high risk parts undergoing a part number change.
Level 4	**Warrant and other requirements as specified by CPSD. This level is reserved for special applications only .** Applied to: This level can only be applied with prior approval from Supplier Quality Management.
Level 5	**Warrant with product samples and complete supporting documentation reviewed at the supplier's manufacturing location. On-Site Level 3 PPAP!!** Applied to: This level is used at the discretion of Supplier Quality for urgent or large components only.