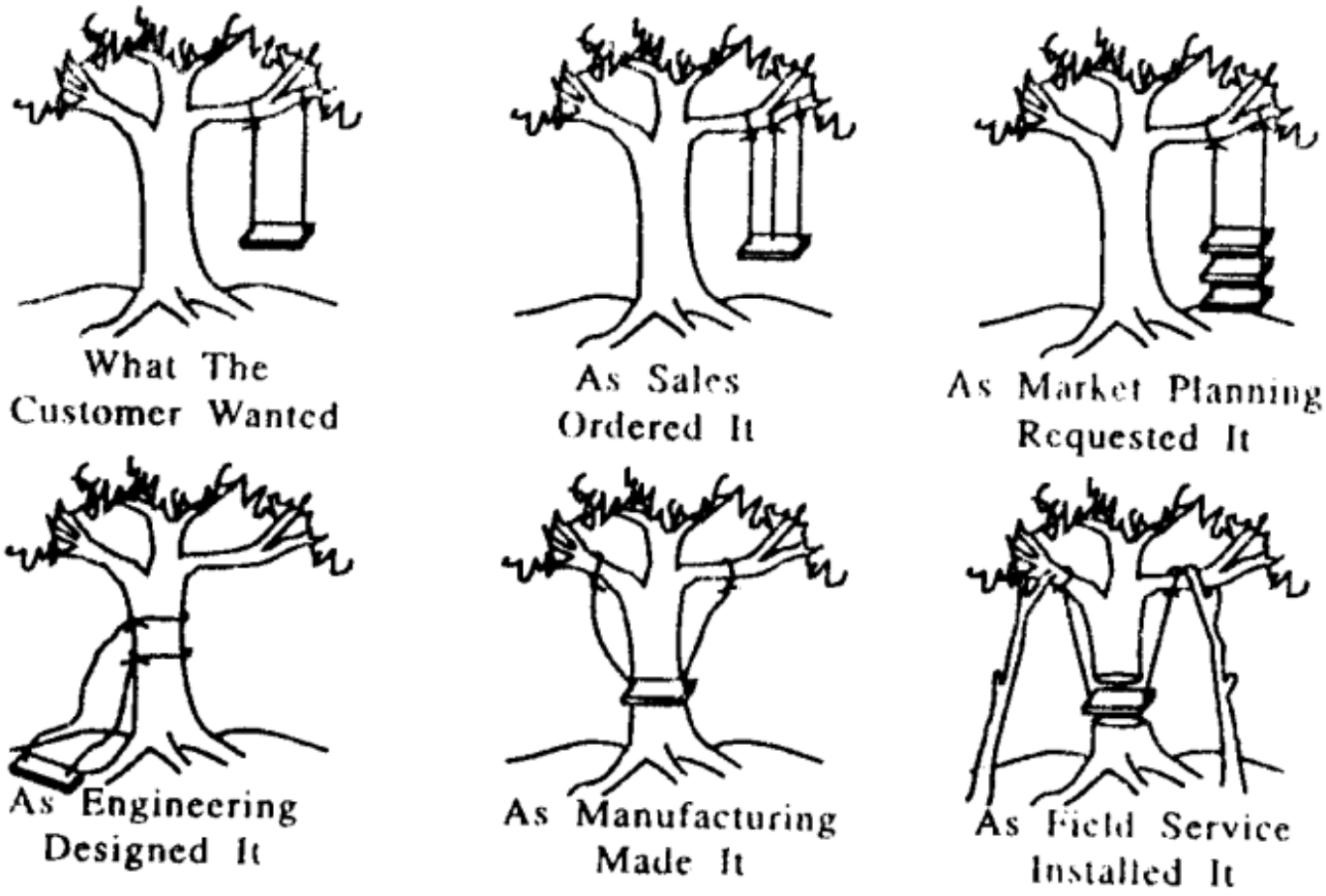
جلسه پنجم، ششم و هفتم: فرآیند توسعه محصول جدید

Introduction

What is the meaning of design?

The design process, is the organization and management of people and the information they develop in the evolution of a product.

Introduction



Introduction

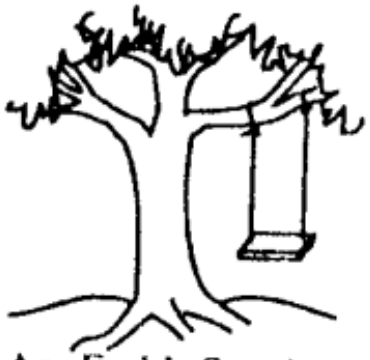
What The
Customer Wanted

As Sales
Ordered It

As Market Planning
Requested It

As Engineering
Designed It

As Manufacturing
Made It



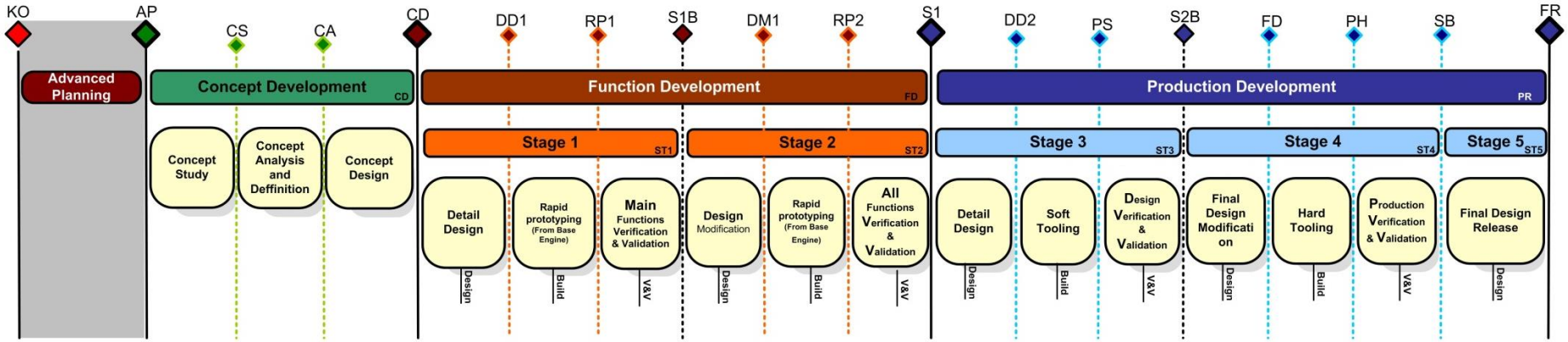
As Field Service
Installed It

Introduction

- New product Development Process starts with Client and his requirements afterward delivers a reliable, verified and validated solution to make Client satisfied at the end.

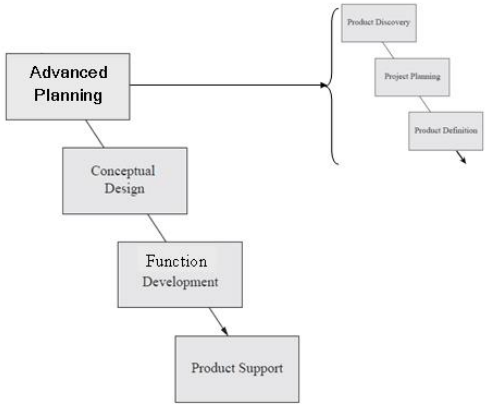
- It has 4 major stages which are monitored by controlling gates and milestones.
  - Advanced Planning
  - Concept Development
  - Function Development
  - Production Development

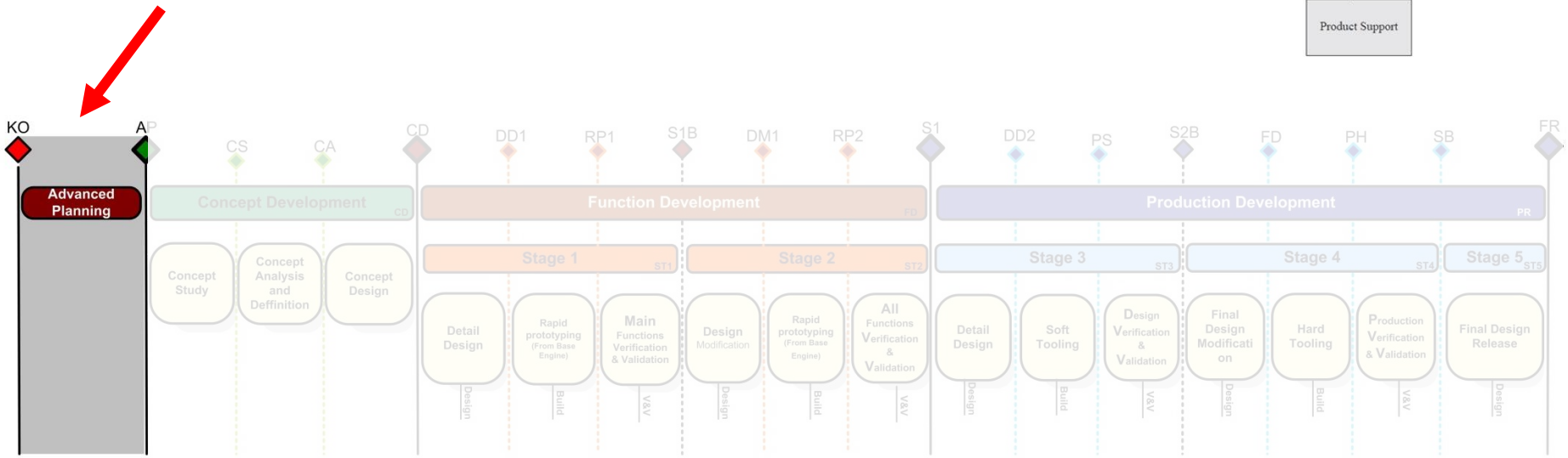
مراحل مختلف توسعه محصول جدید



Advanced Planning Stage

Advanced planning





Advanced Planning Stage

Purpose of "Advanced Planning Stage":

The *"*Advanced Planning Stage*"* with the purpose of preparing roadmaps, strategies and plans based on Client requirements and expectations for both products and project.

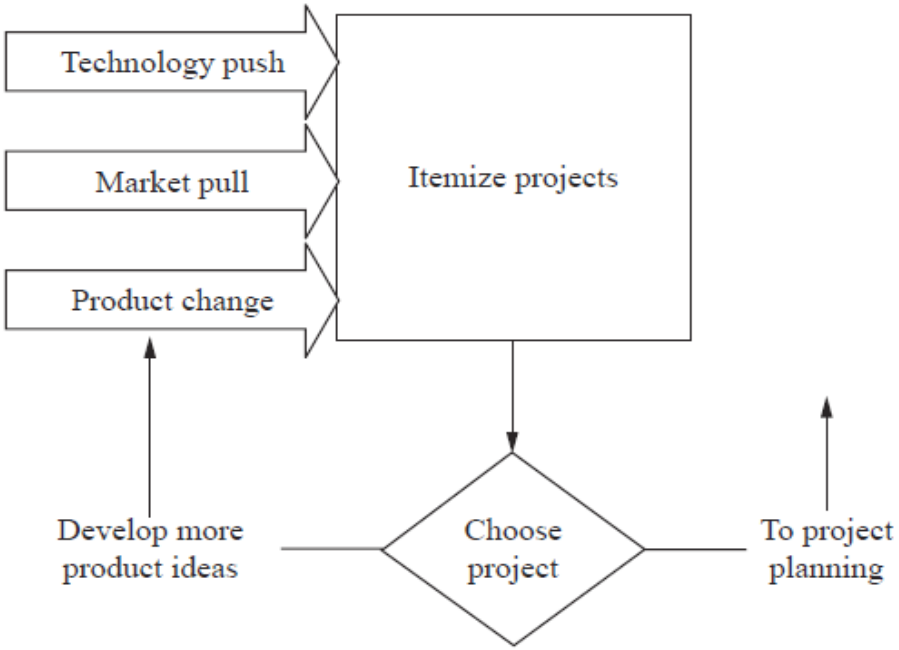
Overall Description:

According to its name, This stage will define product and plan project on acceptable high level of details, based on *"*Requirement List *"*. This stage is divided in three phases. These phases are in order *Product discovery*, *project planning* and *product definition.*

Advanced Planning Stage

1. Product discovery

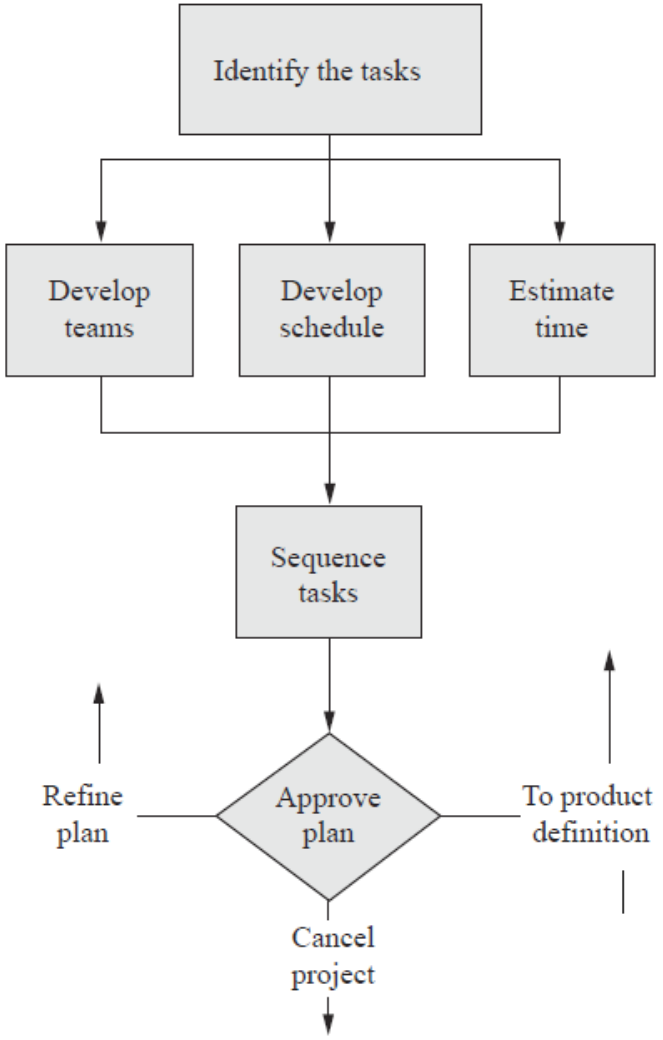
There are three primary sources for design project. As shown in figure, that sources are *Technology push*, *Market pull* and *Product change.*



Advanced Planning Stage

2. Project Planning

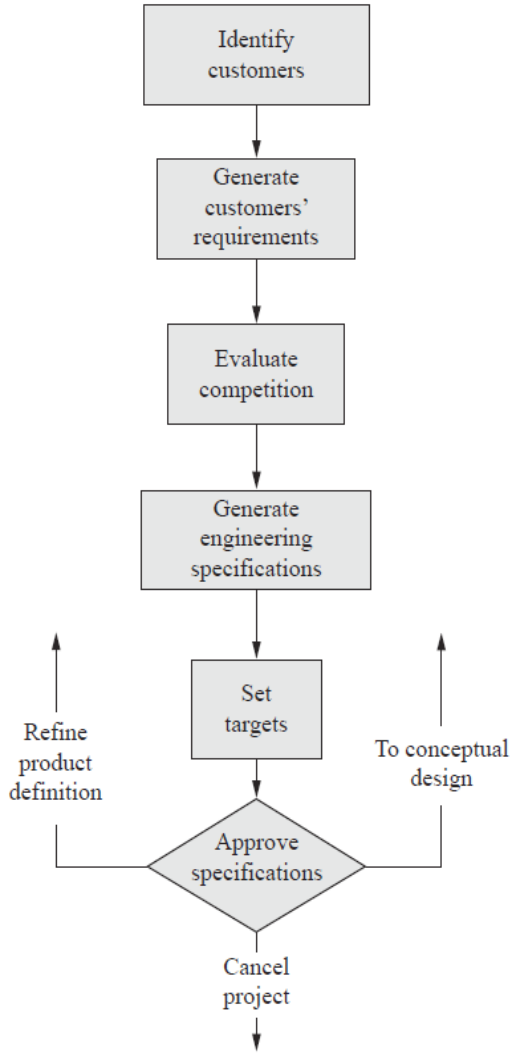
The second phase is to plan so that *the company's resources of money,* people, and equipment can be allocated and accounted for.



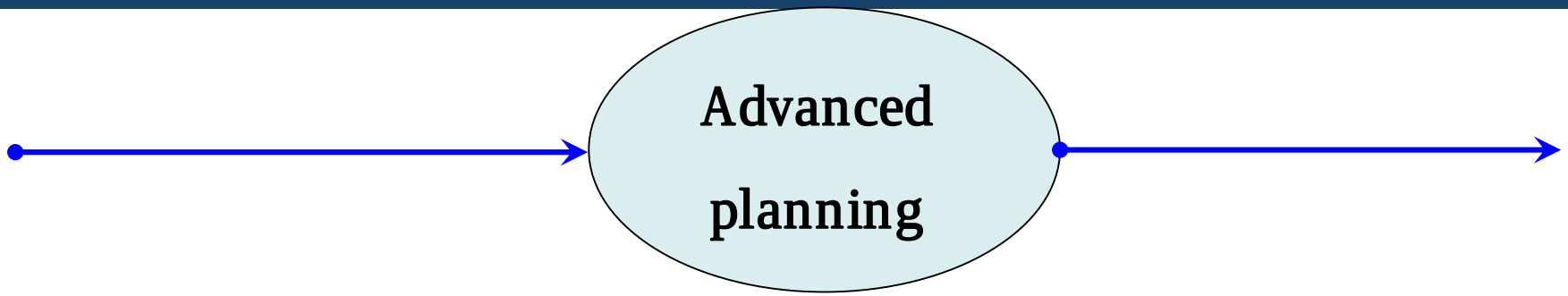
Advanced Planning Stage

3. Product Definition

During the product definition phase, the goal is to understand the problem and lay the foundation for the remainder of the design project.



Advanced Planning Stage



Main Input (s):

- Market pull : Customer requirement (client , costumer & user)
- Technology push : Manufacture cost (Technology and production method)
- Product change :
  - ✓ Time to market (development time and cost)
  - ✓ Stack holders (Governmental rules, standards , environmental limitation & …)

Main Out-put (s):

- Product Development Proposal
- Project Plan (Establish Estimates)
- Requirement List

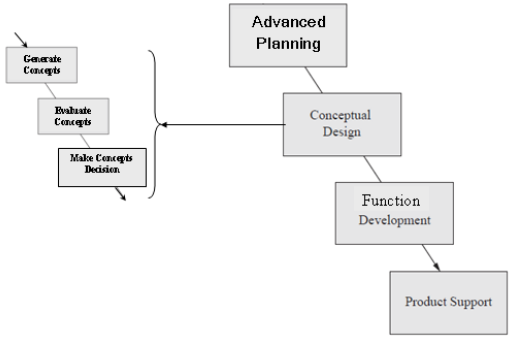
Advanced Planning Stage

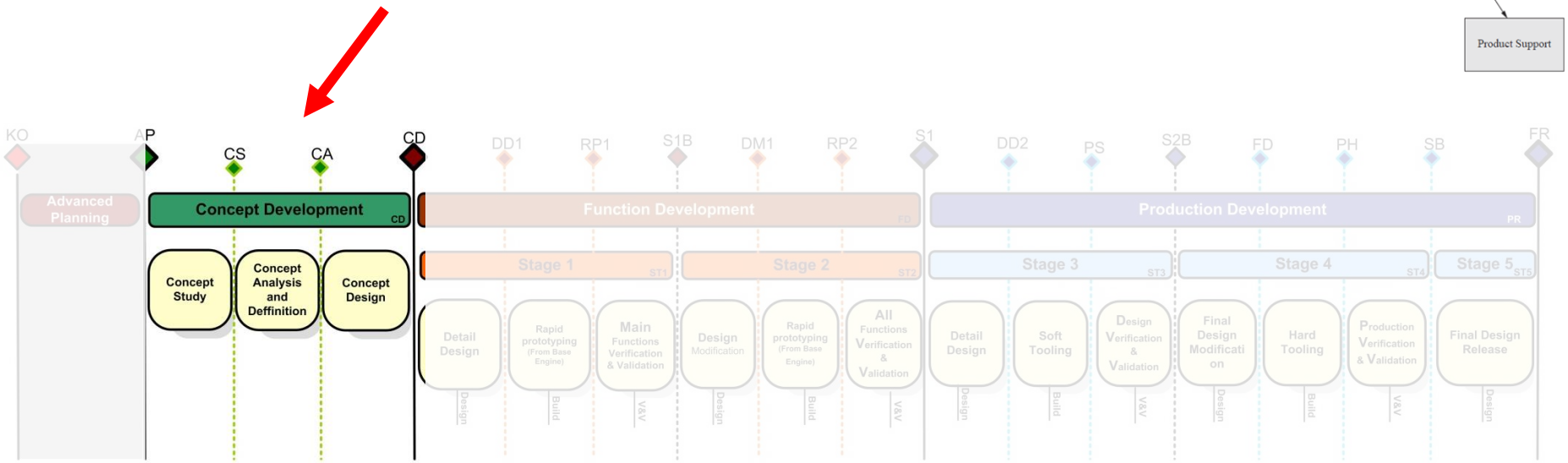
Main Activities:

- **Negotiation with Customer**
- **Benchmarking**
- **Prepare Agreed "Requirement List"**
  - ✓ Main Product Targets
  - ✓ Supply chain Requirements
  - ✓ Production Line and Production Volume Requirement
  - ✓ Cost
  - ✓ Technology Requirements
  - ✓ Vehicle integration Requirements
  - ✓ Re-usability Requirement
- **Preliminary Calculation**
- **Prepare Product Development Proposal**

Concept Development Stage

Concept Development Stage





Concept Development Stage

Purpose of “Concept Development Stage"

The “Concept Development Stage” with the intention of Developing Product Concept and Answer Main Questions about Product and Project in Following Issues:

- Product Components Concept
- Product Systems Concept
- Production Line and Tools Concept
- Product Development Life Cycle Concept and Project Plan

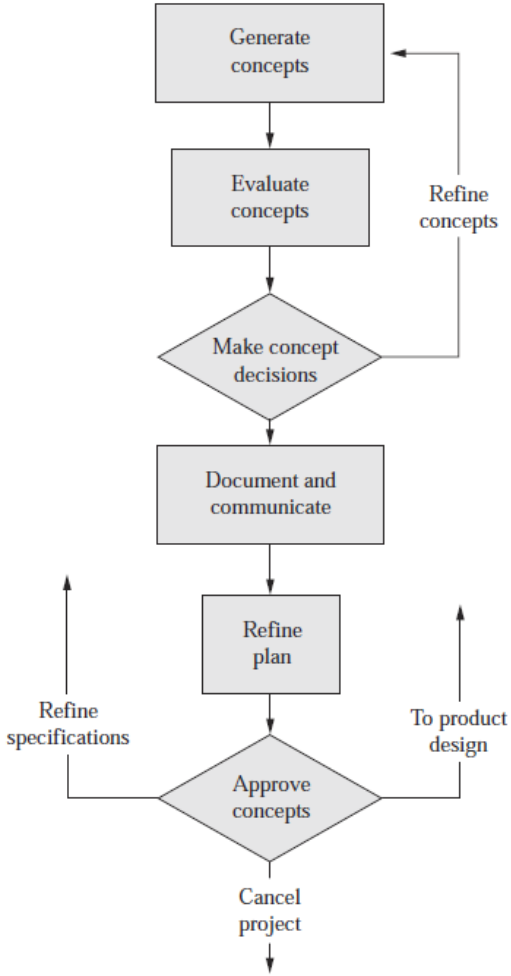
Developed Concepts and Selected Technologies should meet Product and Product Component Targets on its Optimum point.

Concept Development Stage

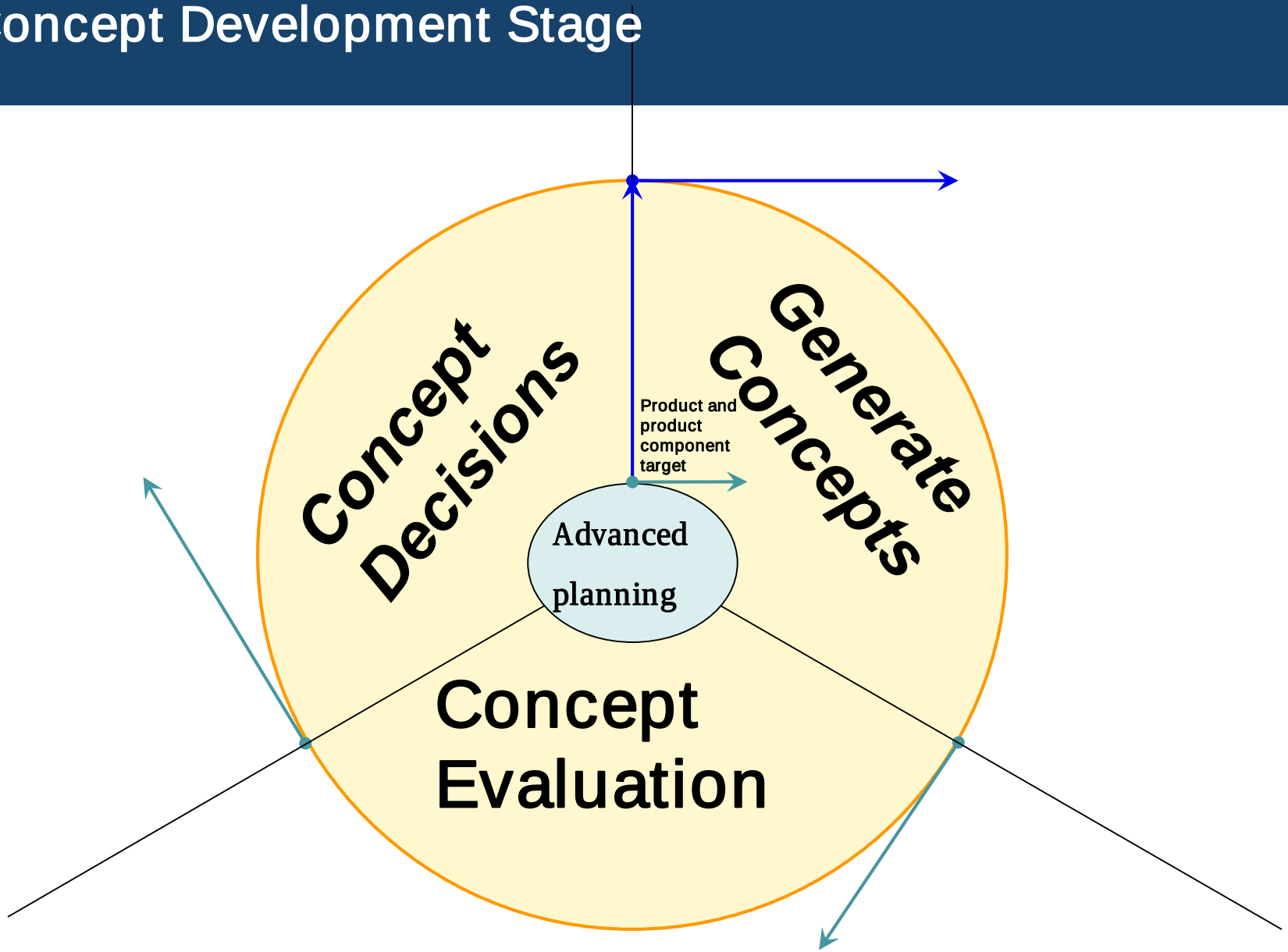
Overall Description :

Designers use the results of the Planning and Product Definition phases to generate and evaluate concepts for the product or product changes.

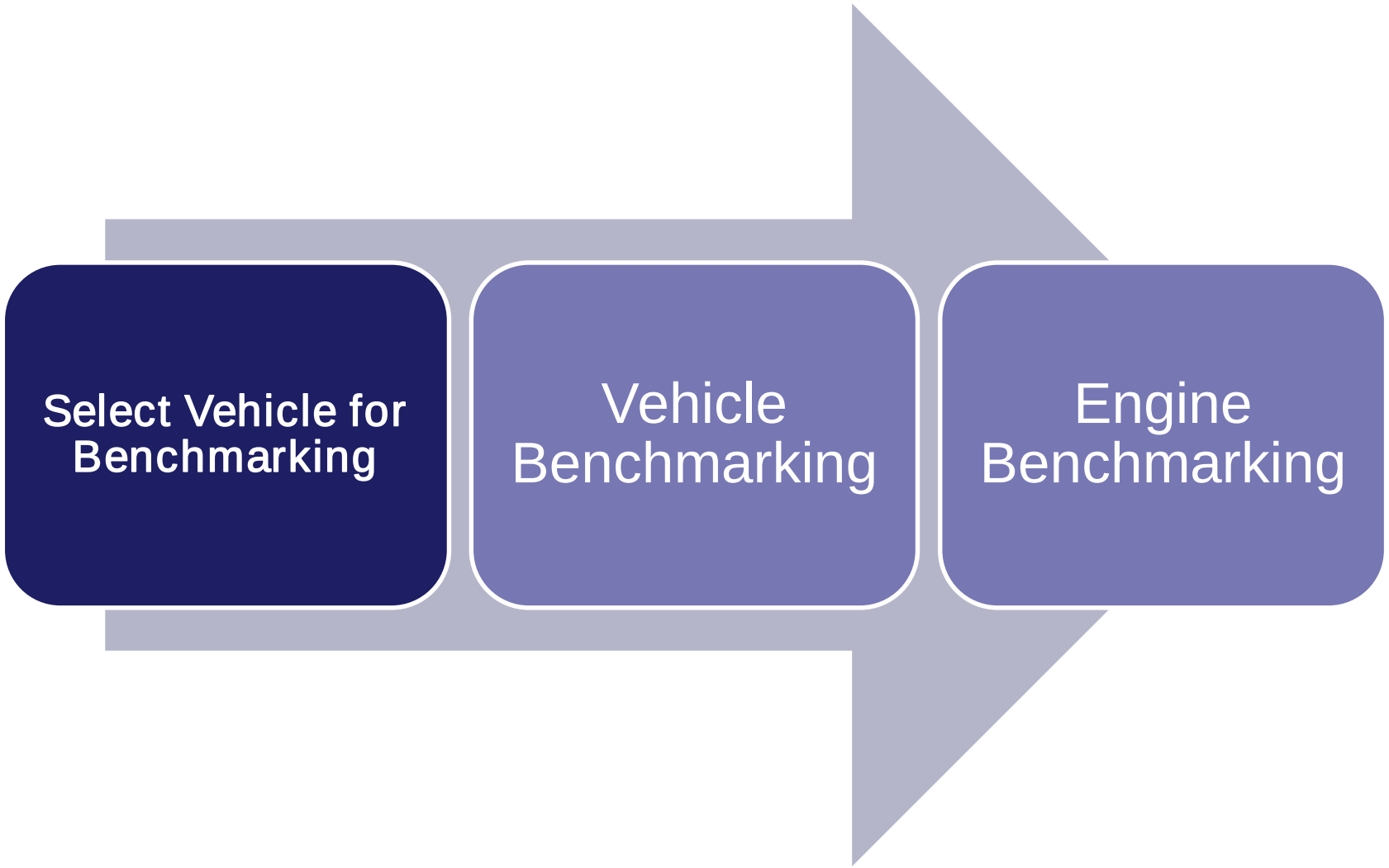
This stage is divided in three phases. These phases are in order *Generate concepts*, *Evaluate Concepts* and *Make Concepts decisions*.



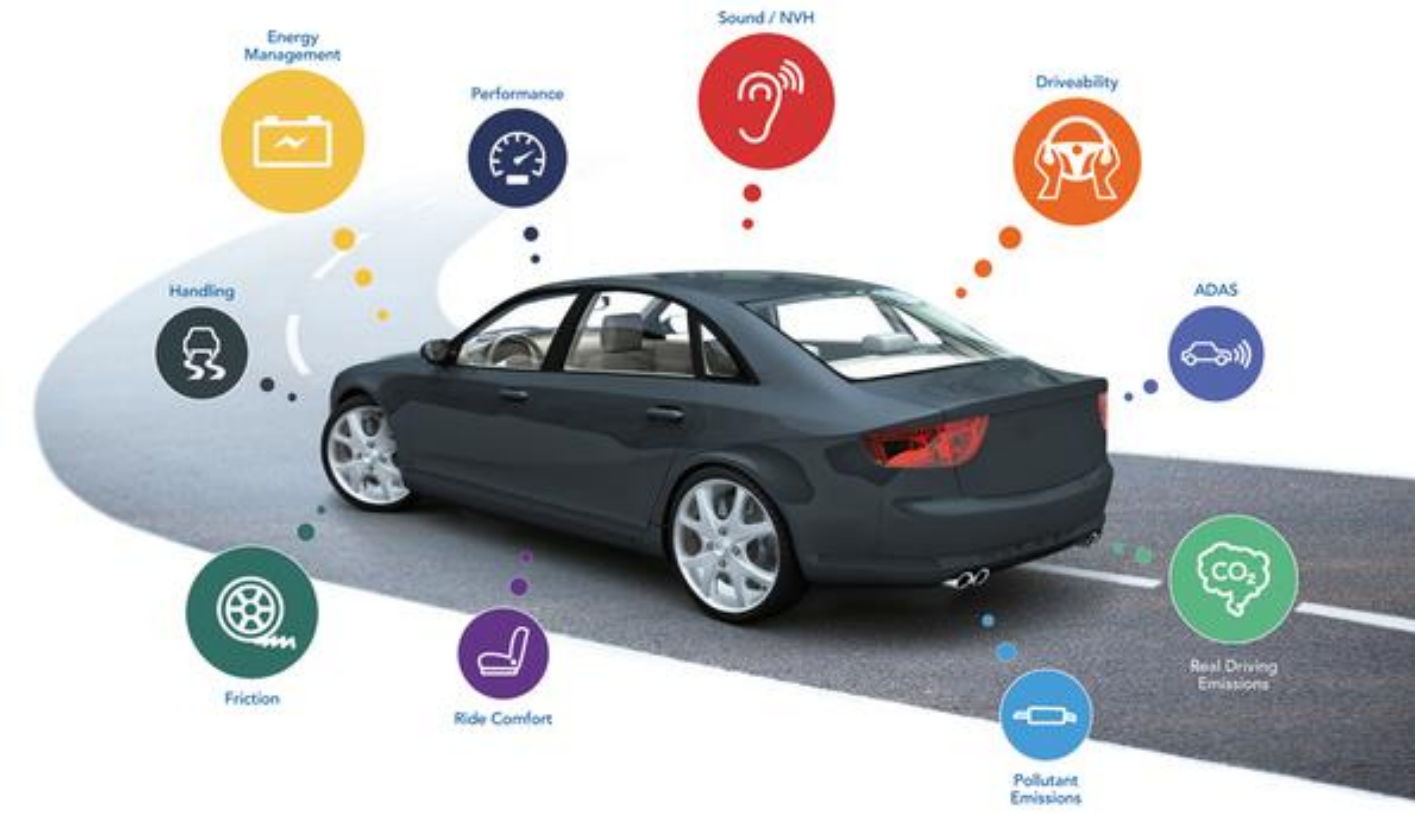
Concept Development Stage



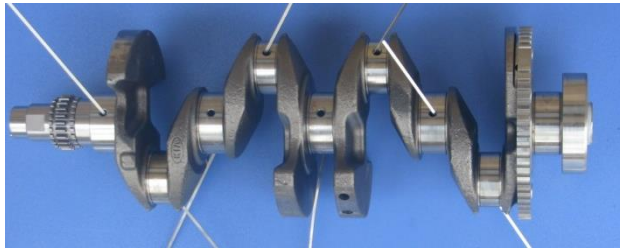
Benchmarking Process



Global Vehicle Benchmarking



Design Features Assessment



	Cost	production	Performance	Assembly line	Repair ability
Four-counter weight crank shaft design	+	+light raw part	- higher NVH level due to lower balancing ratio +lower rotating mass	NE	NE
Machined counter weights outer diameter(to keep the clearance with other components)	-	- additional machining OP	NE	NE	NE
Mounted PM trigger wheel on crankshaft	+	+ Net shape + Few machining Ops + No precise machining on flywheel	NE	- An additional OP(Can be assembled also at supplier side)	NE
Through oil hole on main journals	-	-Additional machining OP	NE	NE	NE
Pressed fit timing drive chain wheel on crankshaft	+	+No need to woodruff key slot machining	+ Lower bolt force required	- Harder assembly	- Harder assembly & disassembly

Reparability	Assembly line	Performance	Production	Cost	Design feature
					
⬇	●	⬆	⬆	⬆	

⬇ increase cost , ⬆ reduce cost , ● No Effect

Concept Design

Inputs:

- » Product Definition (input from advance planning)
- » Production Boundary
- » Supply Strategy (supplier nomination and input)
- » Knowledge and Experience
- » Benchmarking
- » Cost Target
- » Packaging Limitation

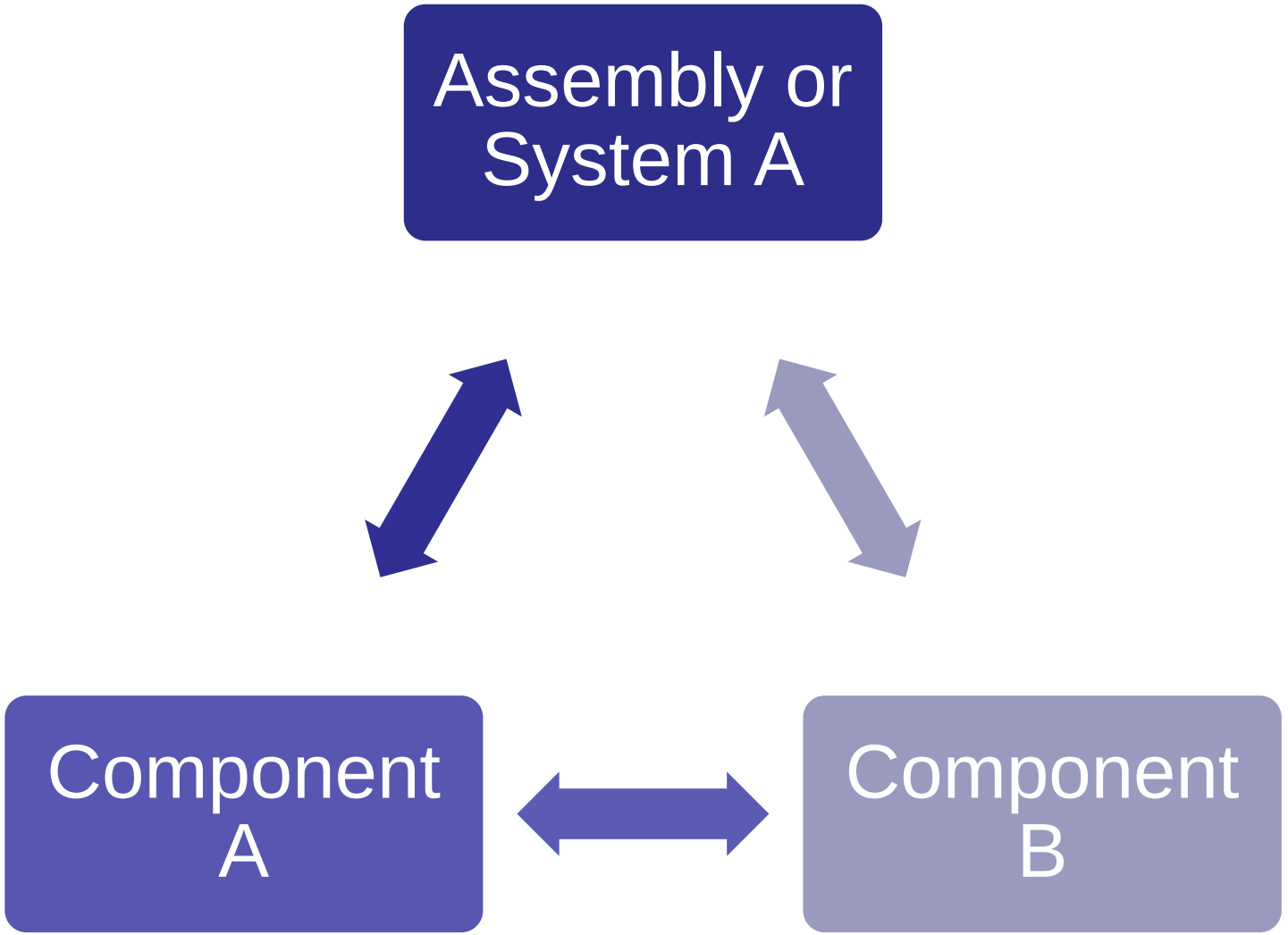
Tasks:

- » CAD Work
- » Preparing BOM (Bill of Materials)
- » Define Production Method
- » Packaging Check
- » Production Analysis
- » Finding and Evaluating Solutions and Targets
- » 1D Simulation
- » Technology and Supplier Evaluation

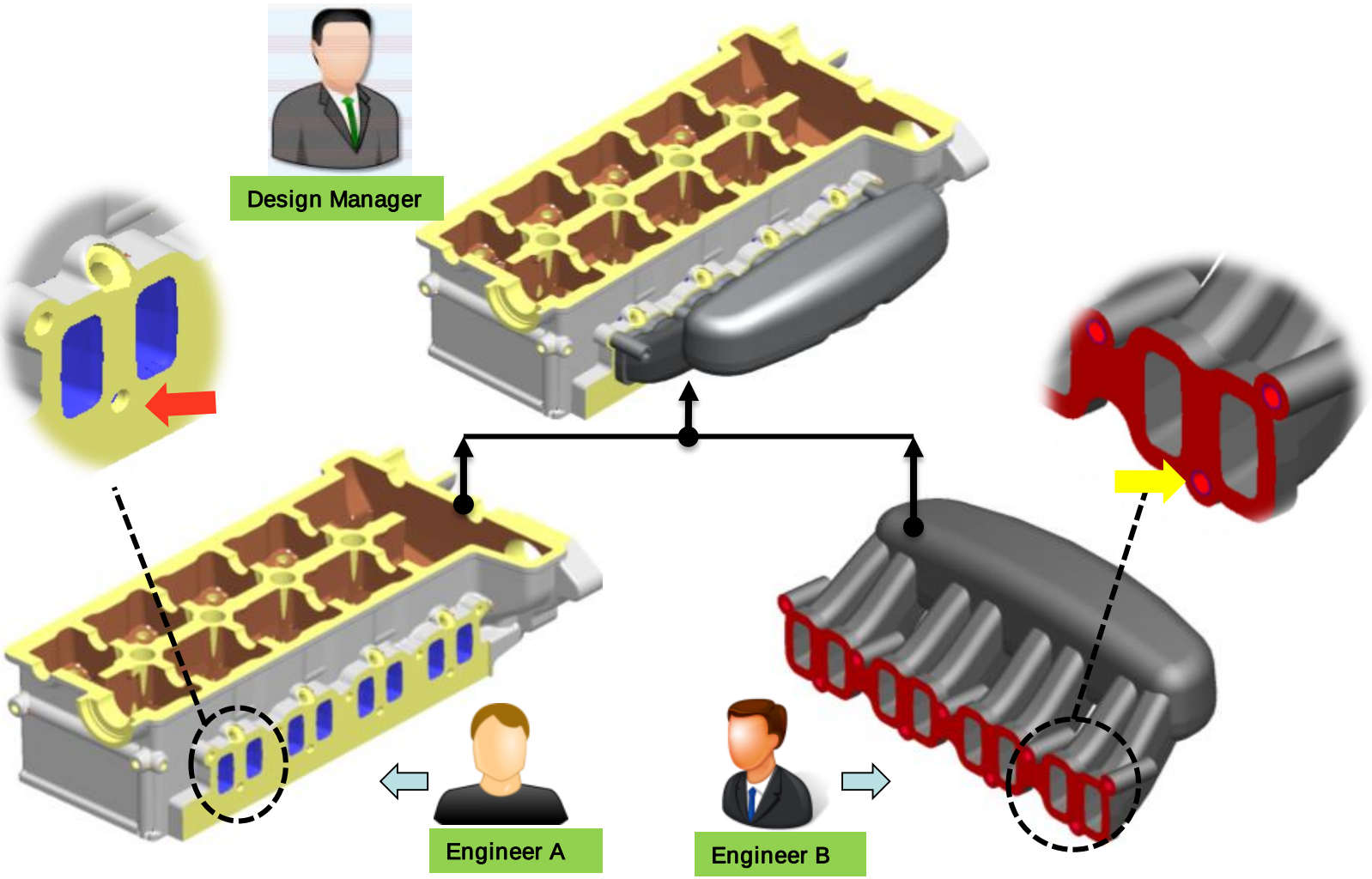
Output:

- » CAD (Rough 3D)
- » BOM (Bill of Materials)
- » Cost Pack
- » Digital Mockup Model
- » Production Analysis Report
- » Supplier Strategy Report
- » PDS (System)
- » Target Book
- » CAE Results Reports
- » Technology Selection Reports
- » TSM (Technical Specification Manual)
- » Evaluation Tables

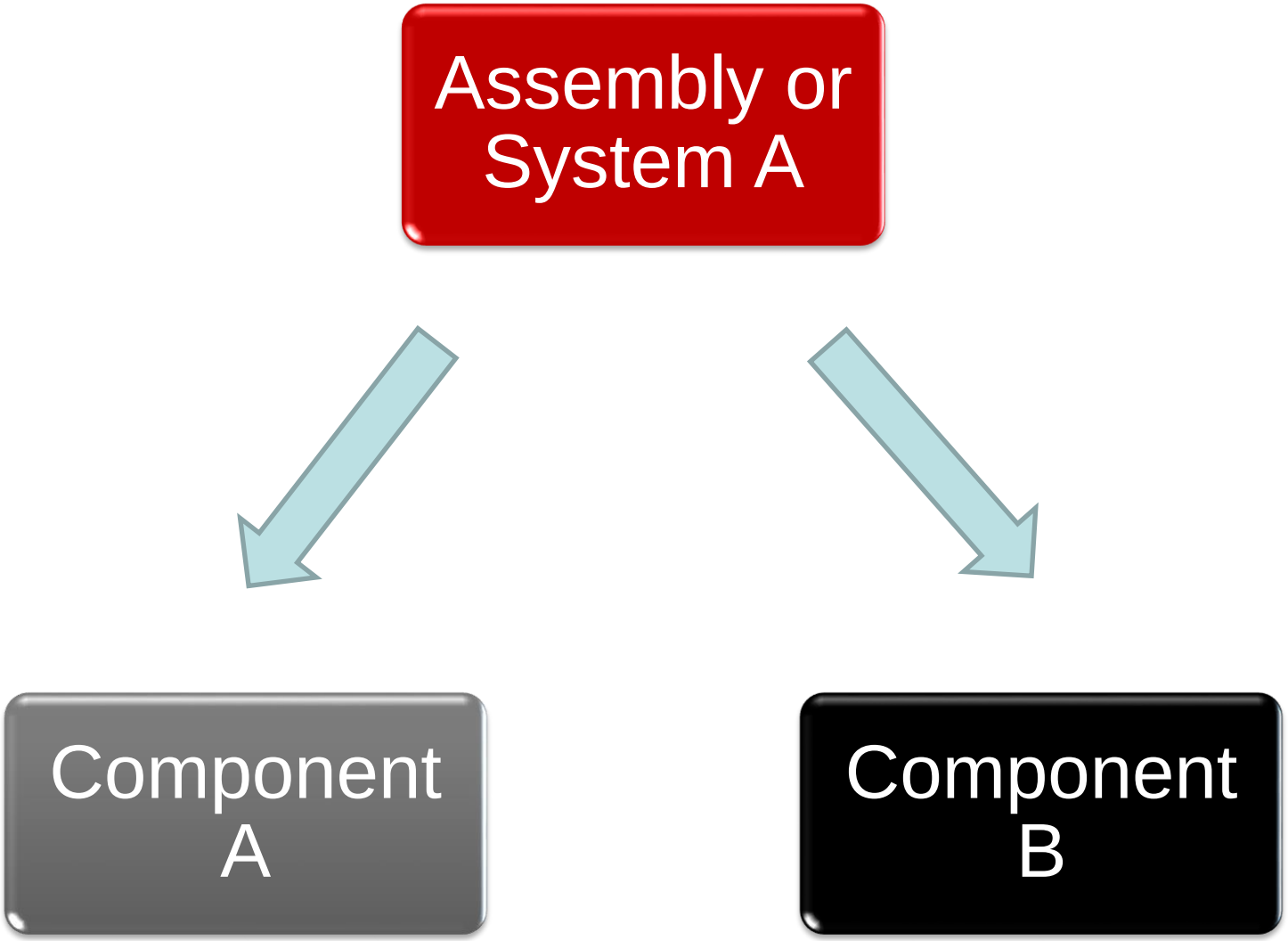
Bottom Up Design



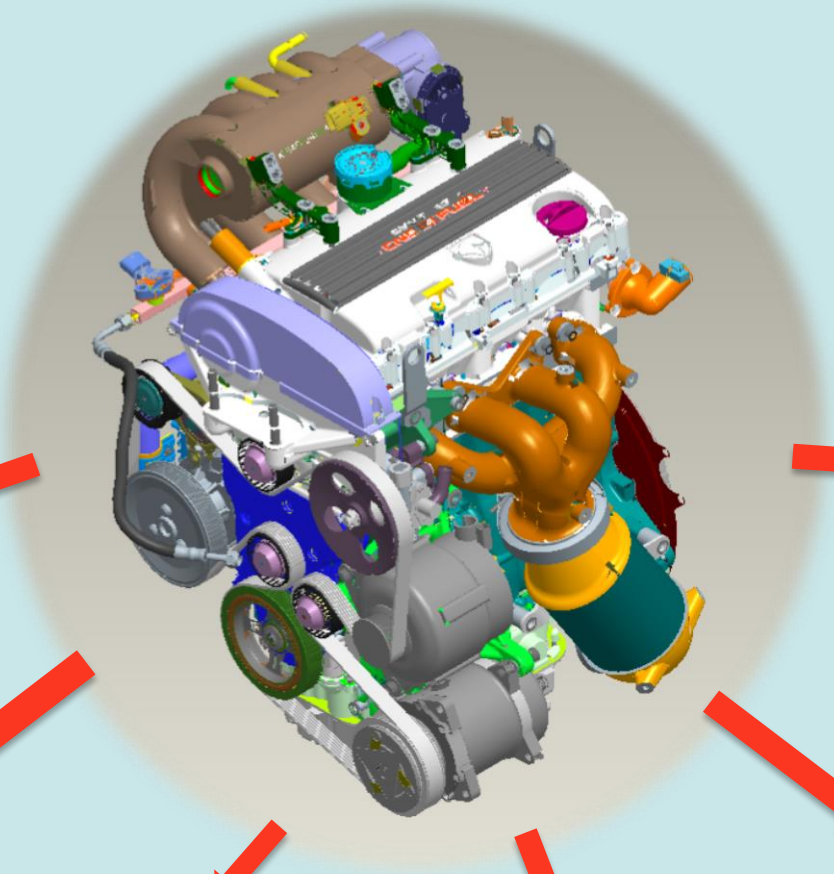
Bottom Up Design



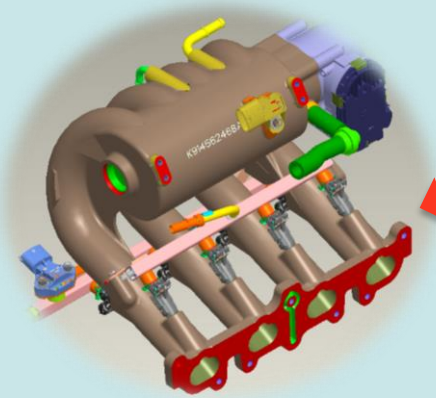
Top Down strategy



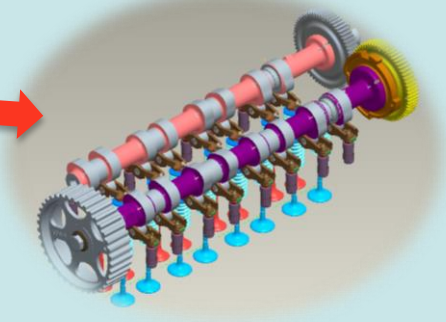
Engine Assembly

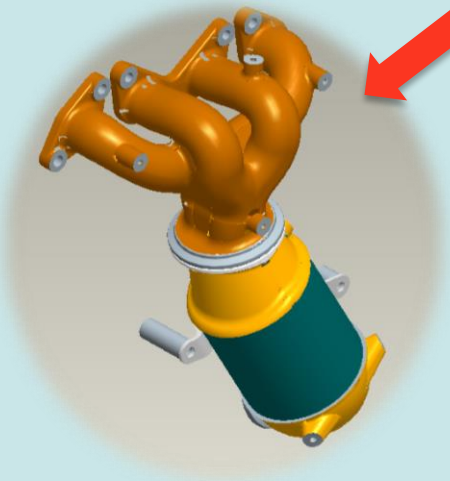


Intake system



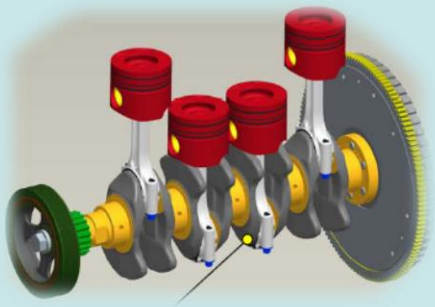
Valve train

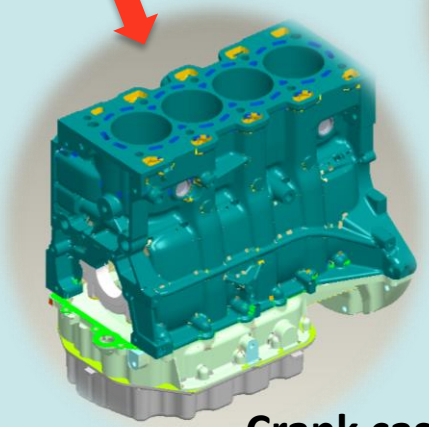




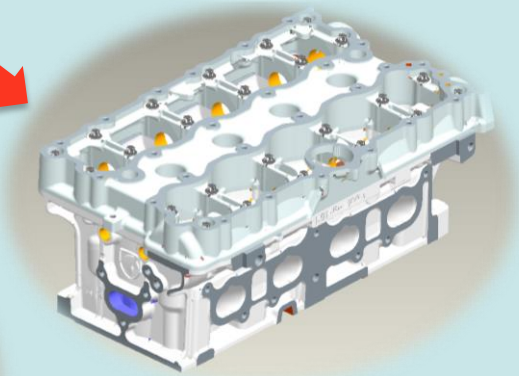
Exhaust system

Crank train



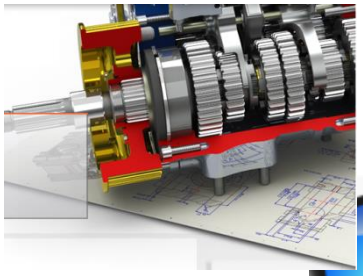


Crank case

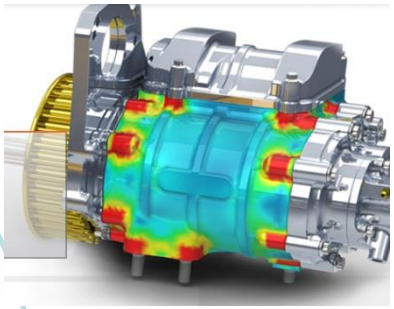


Cylinder head

Product development without data management

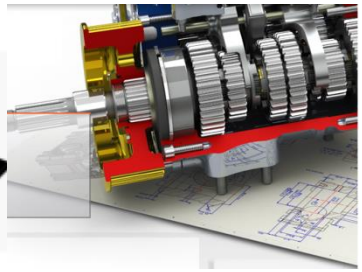



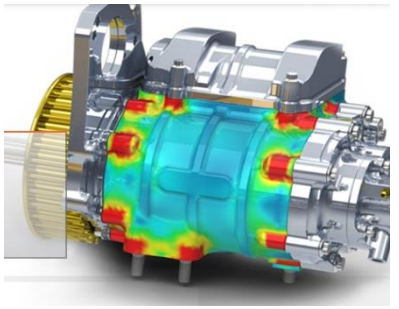


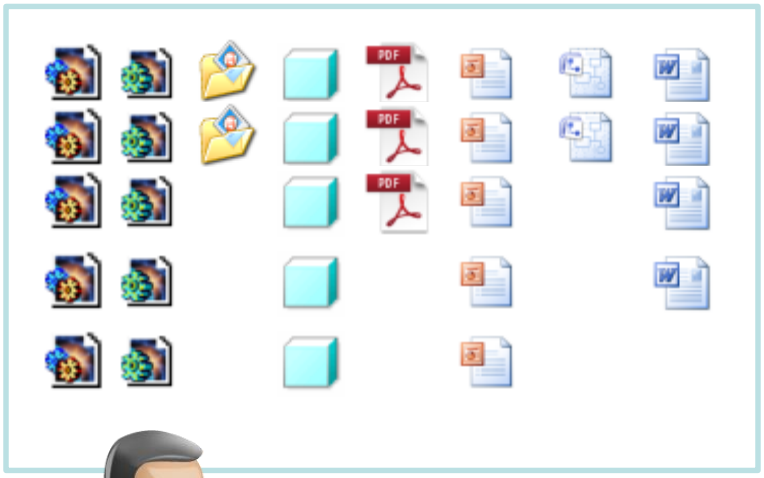




Product development with data management





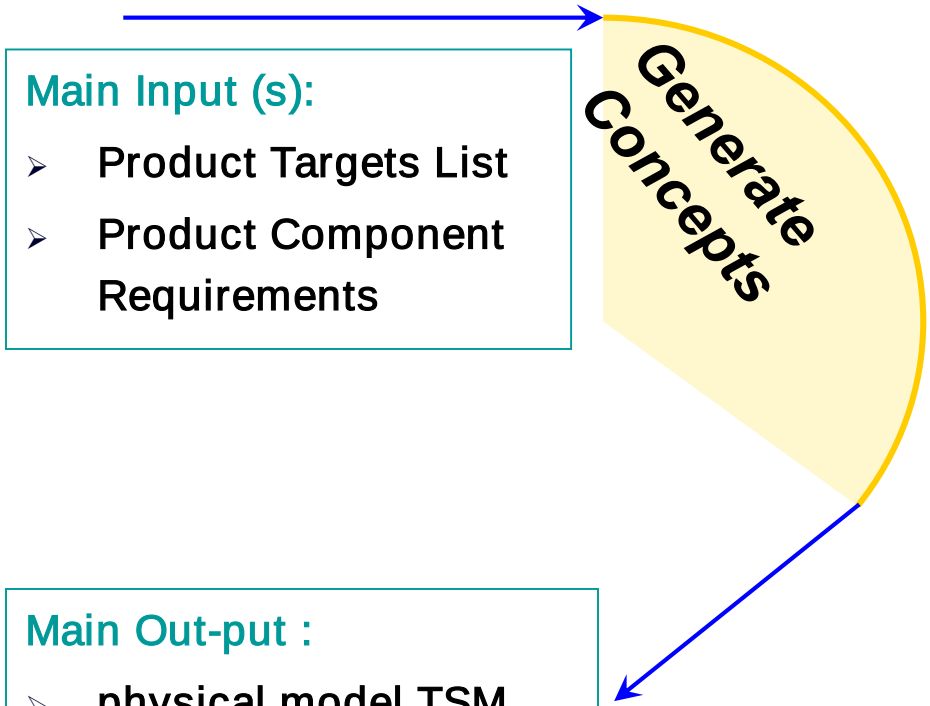


Generate Concept stage

1. *Generate Concept*

When we generate concepts, the customer's requirements serve as a basis for developing a functional model of the product.

The most feasible concept of product components and product systems will be developed by concept Development team based on "Product Targets List" and "Product Component Requirements".



Evaluate Concepts stage

2. Evaluate Concepts

The goal of *Evaluate concepts* is to compare the concepts generated to the requirements developed during Product Definition and make decisions.

Some rough 3D models of components will be generated. Initial and unmatured configuration of model is made by designer team. *Generate Concepts* team starts **CAE calculation** and runs **some tests** on test rig on model. For example physical model aspiration systems such as intake and exhaust port models are tested.

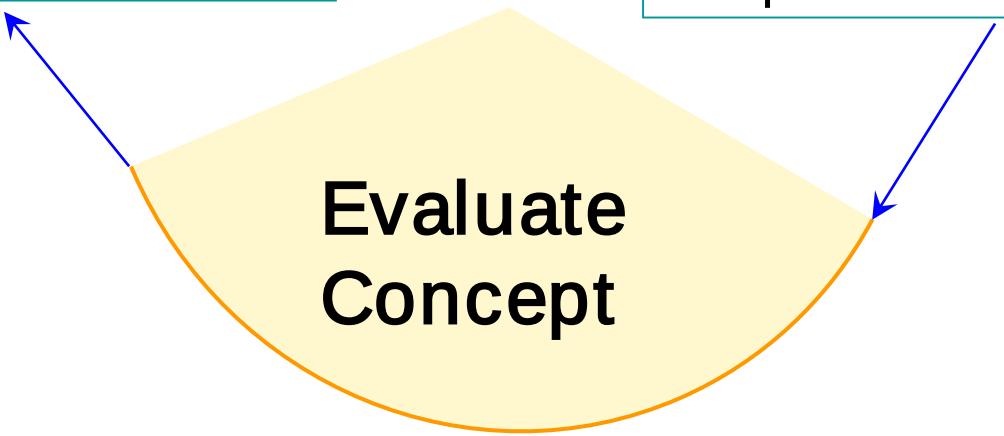
Evaluate Concepts stage

Main Output :

- Rough 3D models of physical model components

Main Input :

- physical model TSM (Technical Specification Manual)



Main Activities:

-Port Development

- 1D Gas-Exchange calculation

- CFD Analysis of Intake Port and In-Cylinder Flow

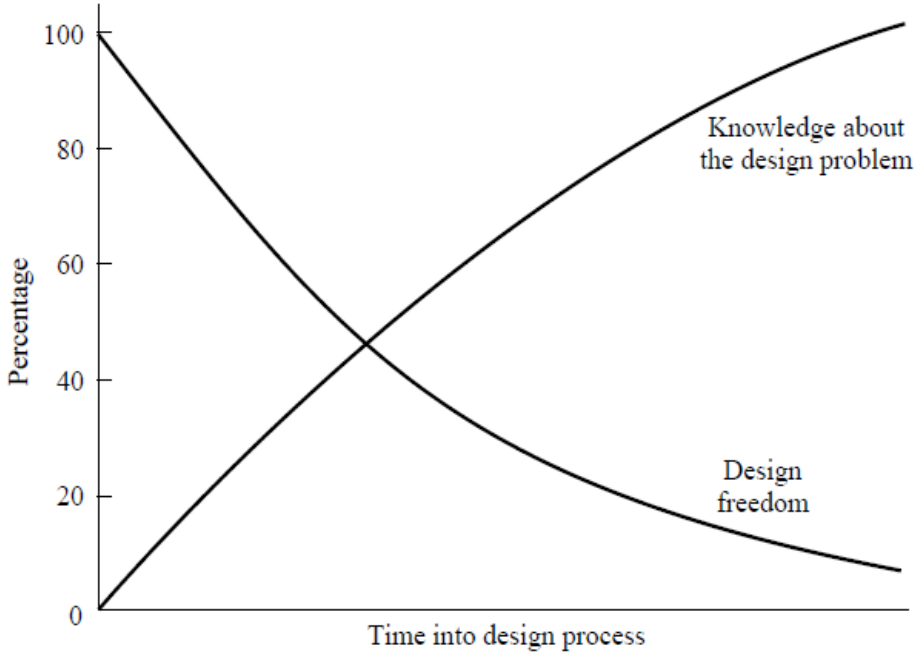
- Intake and/or Exhaust Port Flow Measurement on flow meter

Make Concepts Decisions stage

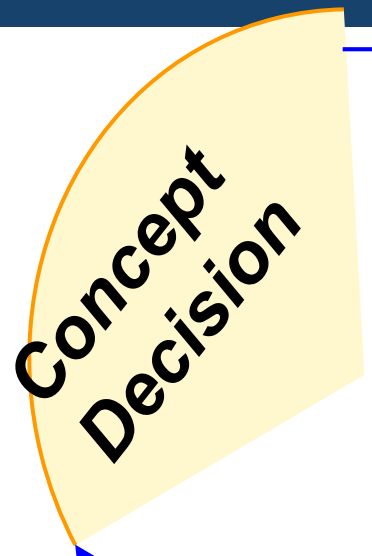
3. Make Concepts Decisions

Concept decisions are made with limited knowledge. As shown in Figure knowledge increases with time and effort. One goal in Conceptual Design is choosing the best alternatives with the least expenditure of time and other resources needed to gain knowledge.

Top down design process starts in this stage. First 3D CAD models should be issued based on results of two previous steps. Generally all concepts developed is verified and validated by generating 3D



Make Concepts Decisions stage



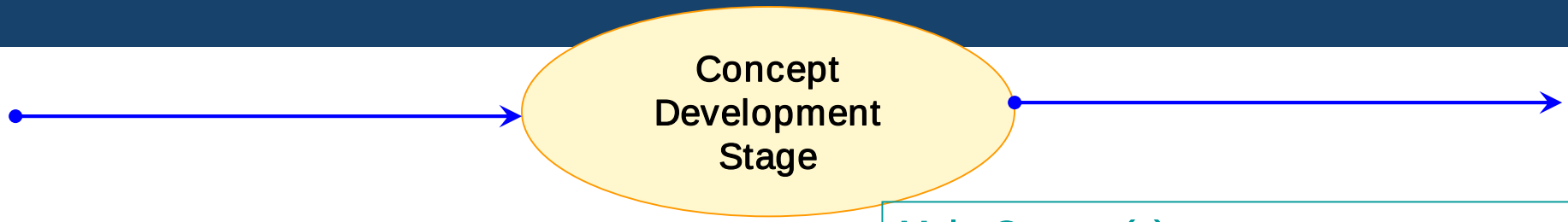
Main Output :

- physical model BOM
- physical model Skeleton and Bin part
- physical model Component and Part Layouts
- Part 3D models
- Design Failure mode and Effect Analysis Reports - DFMEA
- Design Validation Plan and Report (DVP&R)
- Cost Pack of Components and Parts

Main Input :

- Rough 3D models of physical model components
- physical model TSM (Technical Specification Manual)

Concept Development Stage



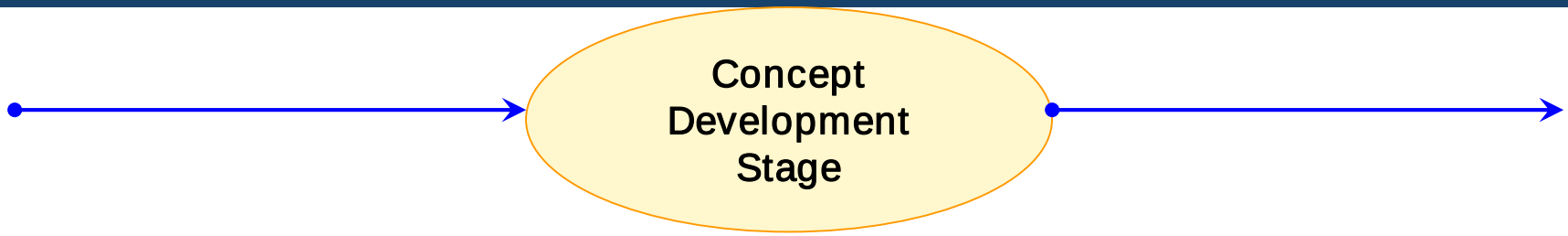
Main Input (s):

- User Requirement List
- Project Plan (Establish Estimates)
- Product Definition (input from advance planning)
- Production Boundary
- Supply Strategy (supplier nomination and input)
- Knowledge and Experience
- Benchmarking
- Cost Target
- Packaging Limitation

Main Output (s):

- CAD (Rough 3D)
- BOM (Bill of Material)
- Digital Mockup Model
- Production Analysis Report
- Supplier Strategy Report
- PDS (system)
- Target Book
- CAE Results Reports
- Technology Selection Reports
- TSM (Technical Specification Manual)
- Evaluation Tables
- DFMEA , DVP&R and Cost Packs

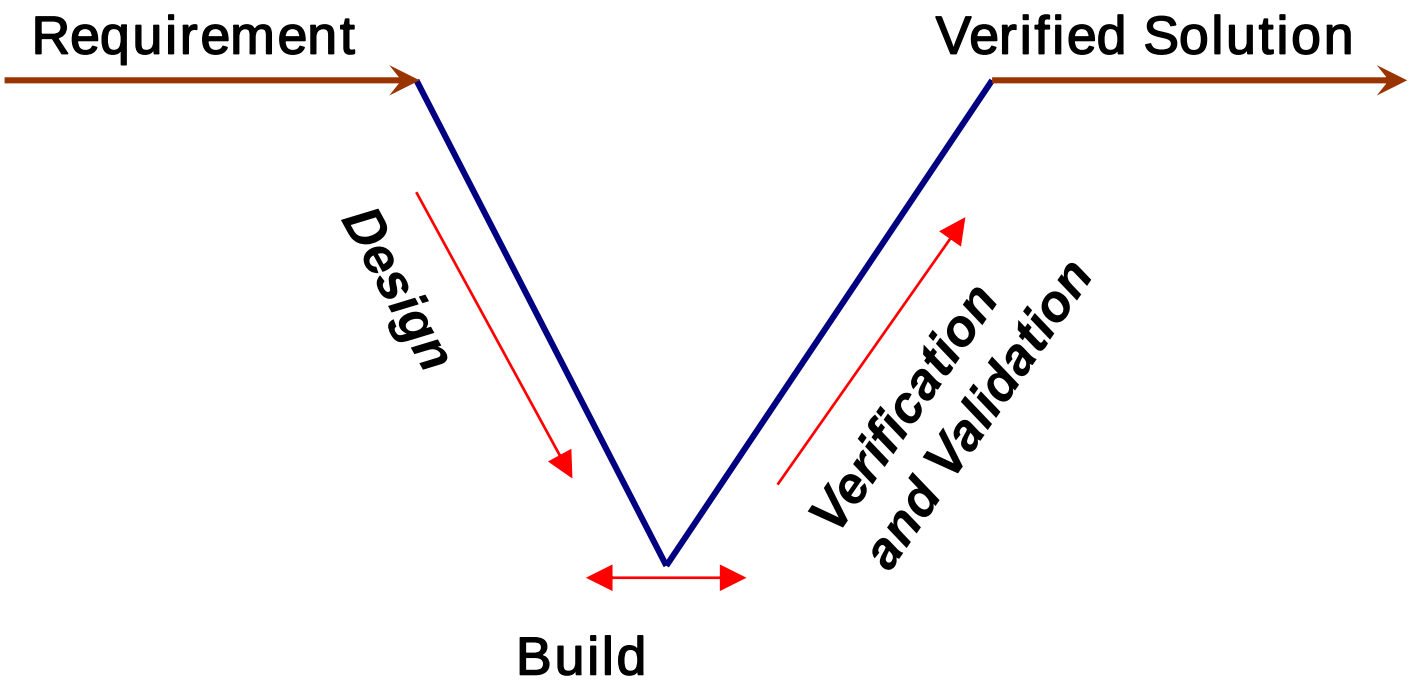
Concept Development Stage



Main Activities:

1. Cad Work
2. Preparing BOM (Bill of Material)
3. Define Production Method
4. Set Targets for Product Attributes
5. Packaging Check
6. Production Analysis (Develop verified Product and Product Component Concepts)
7. Finding and Evaluation Solution and Targets
8. 1D Simulation
9. Technology and Supplier Evaluation

System Development Life Cycle

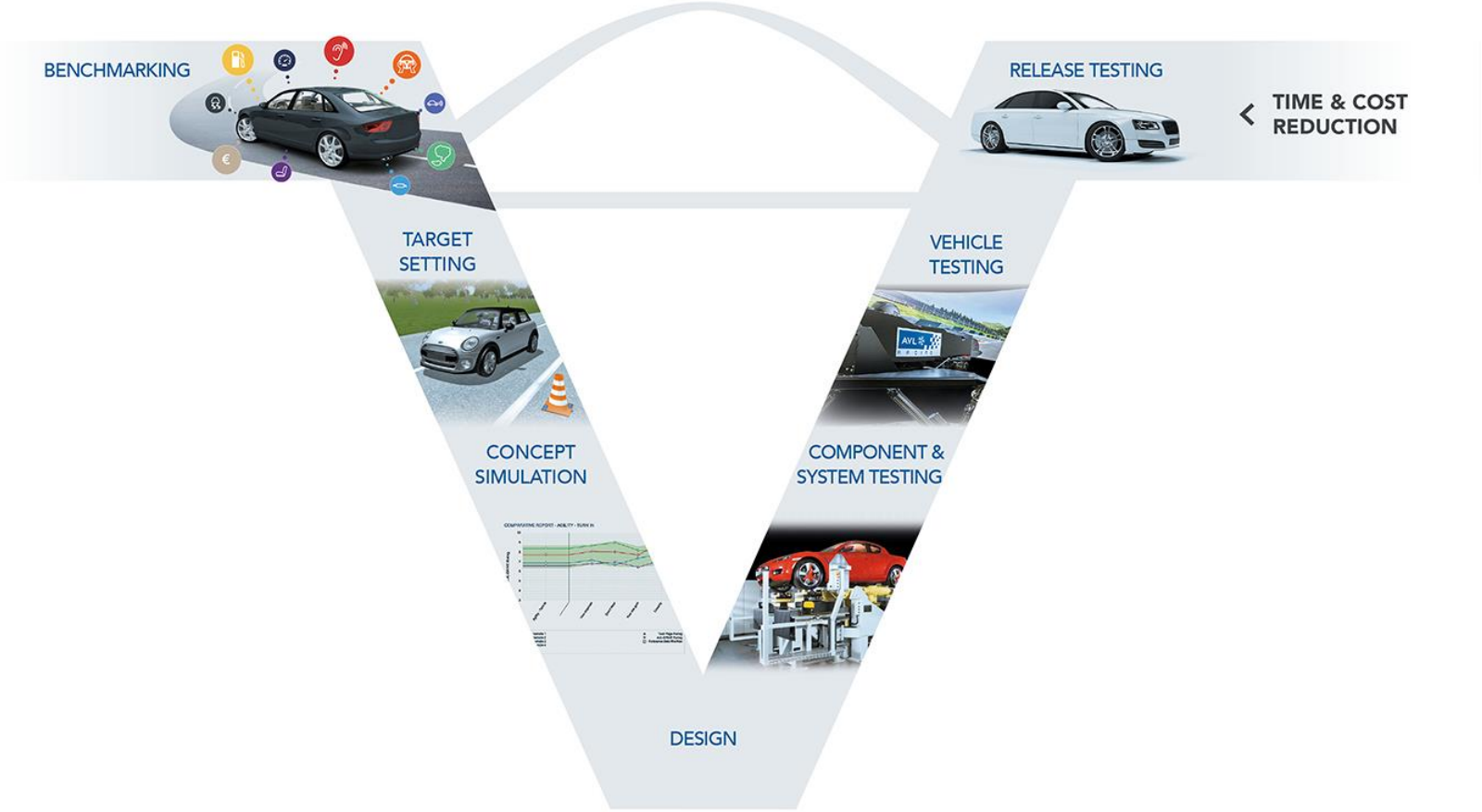


- System Development Life Cycle for Powertrain Development

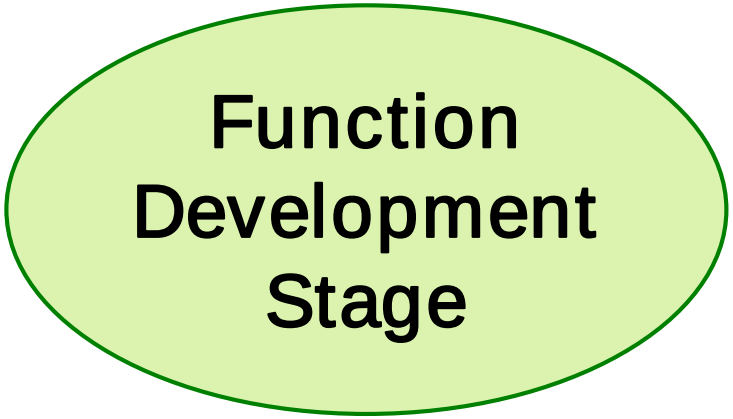
  - V – Model Contains ***Design*** , ***Build*** , ***Verification and Validation*** Sections

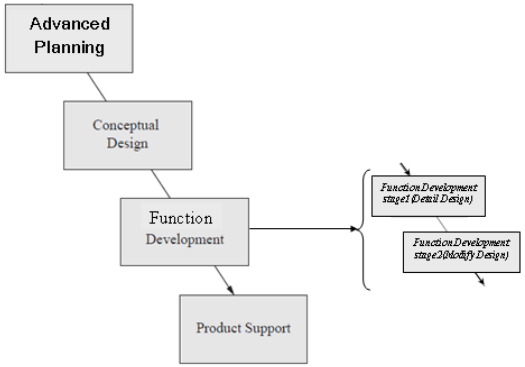
  - Spiral Model Repeats -V- model to start with Concept Phase after that production and matures product design in every iteration.

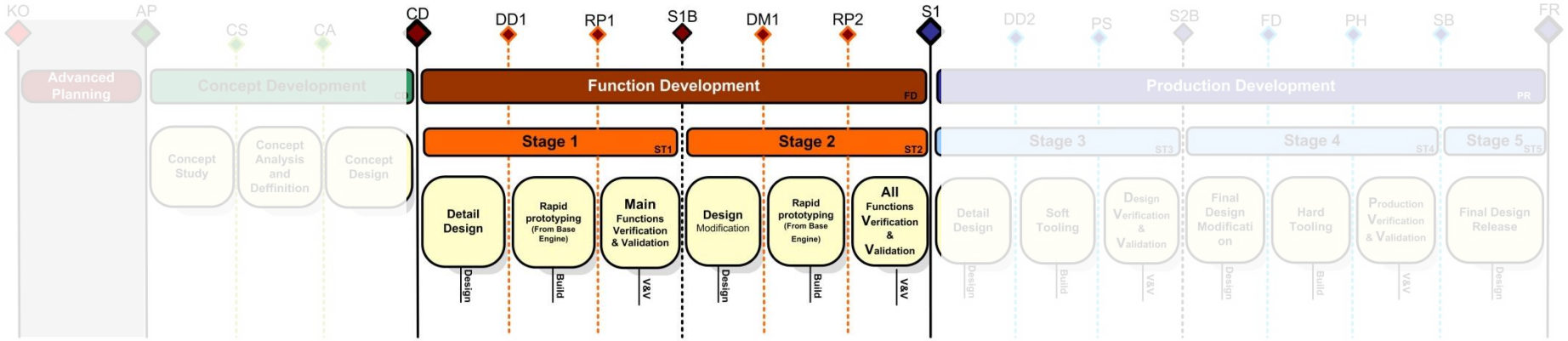
Example


BENCHMARKING
RELEASE TESTING
TIME & COST
REDUCTION
TARGET
SETTING
VEHICLE
TESTING
CONCEPT
SIMULATION
COMPONENT &
SYSTEM TESTING
DESIGN

Function Development Stage







Function Development Stage

Purpose of “Function Development Stage”

The function Development Stage in order to design , verify and validate the physical model functions and finalize configuration of physical model design ,so that physical model Functional Configurations Meets Targets.

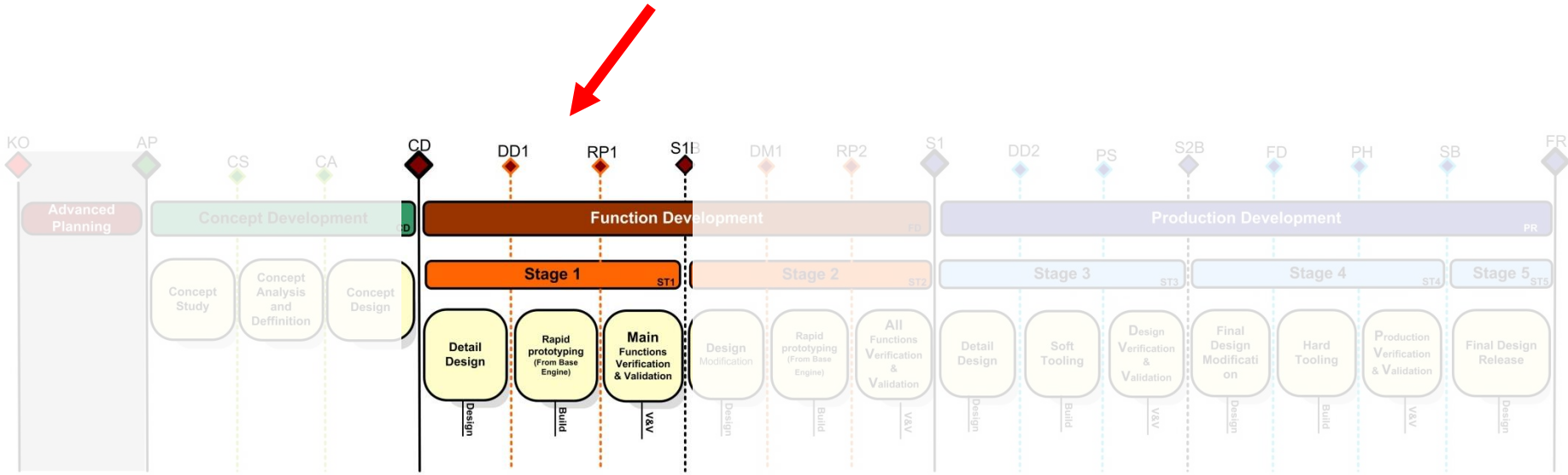
This stage divide in two stage :

-Stage 1

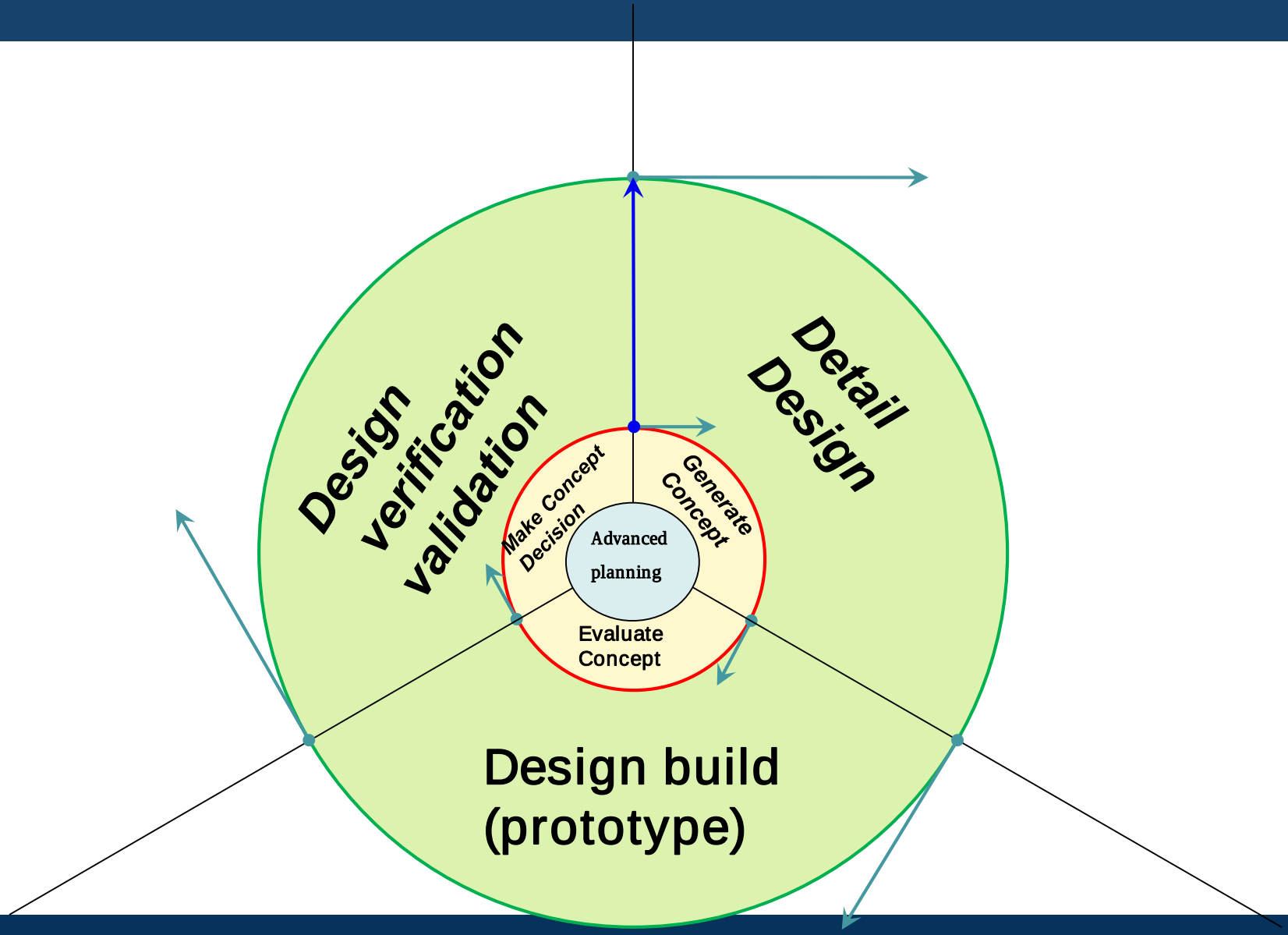
-Stage 2

Function Development Stage1

Function Development Stage1



Function Development Stage1



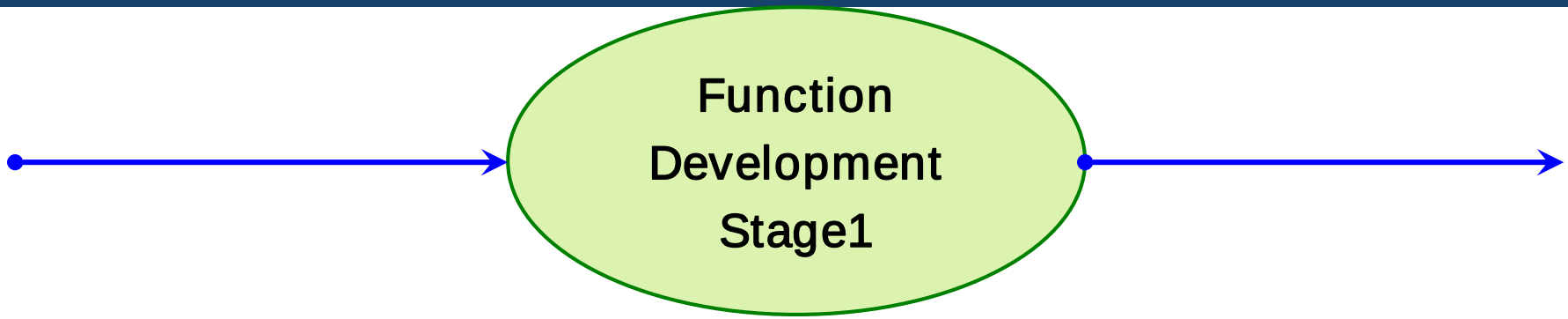
Function Development Stage 1

Stage1:

Overall Description:

According to this stage , the first physically model is designed with most importantly detail. This stage matures physically model function and rich main targets and satisfy requirements define in Product and Product Component Requirement.

Function Development Stage 1



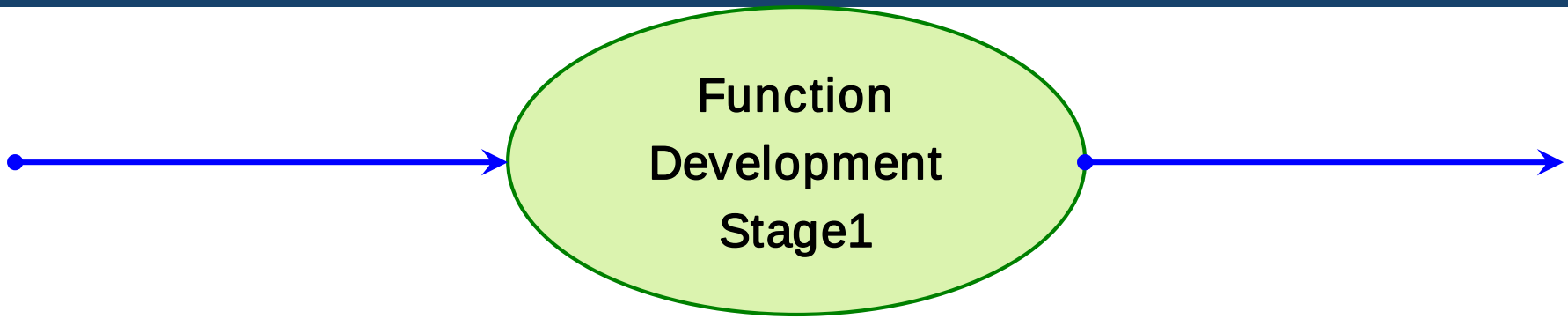
Main inputs:

- Product and Product Component Requirements
- DFMEA
- DVP&R
- physical model Target Book
- physical model Layout Models

Main outputs:

- Stage 1 2D Drawing (as A release)
- Stage 1 3D models
- Combustion Assessment on Mule physical model Report
- Main targets meet report
- Product and Product Component Requirement and validation Report

Function Development Stage 1

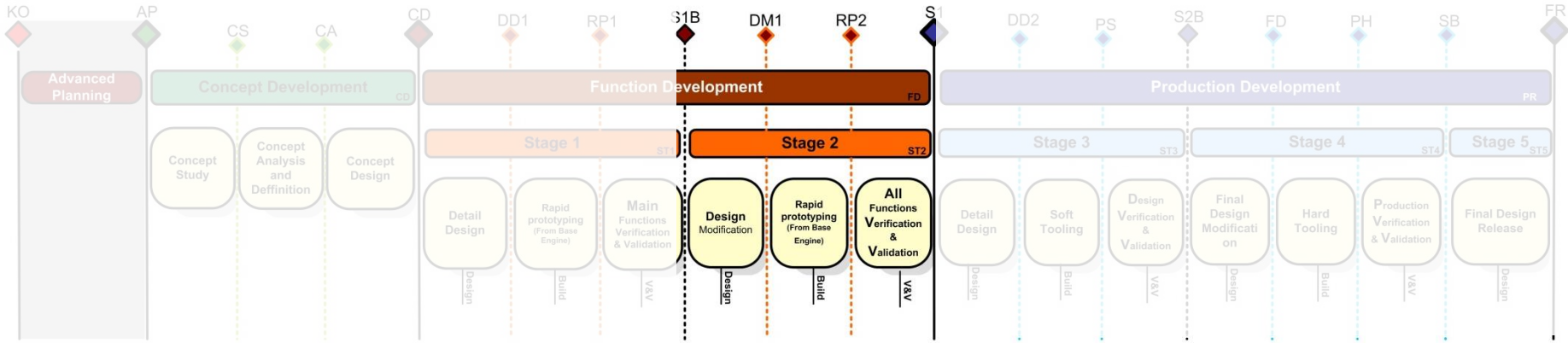


Main Activities:

- physical model Functional Design
- physical model Physical Design
- Combustion Development
- Mule physical model Procurement

Function Development Stage2

Function Development Stage2



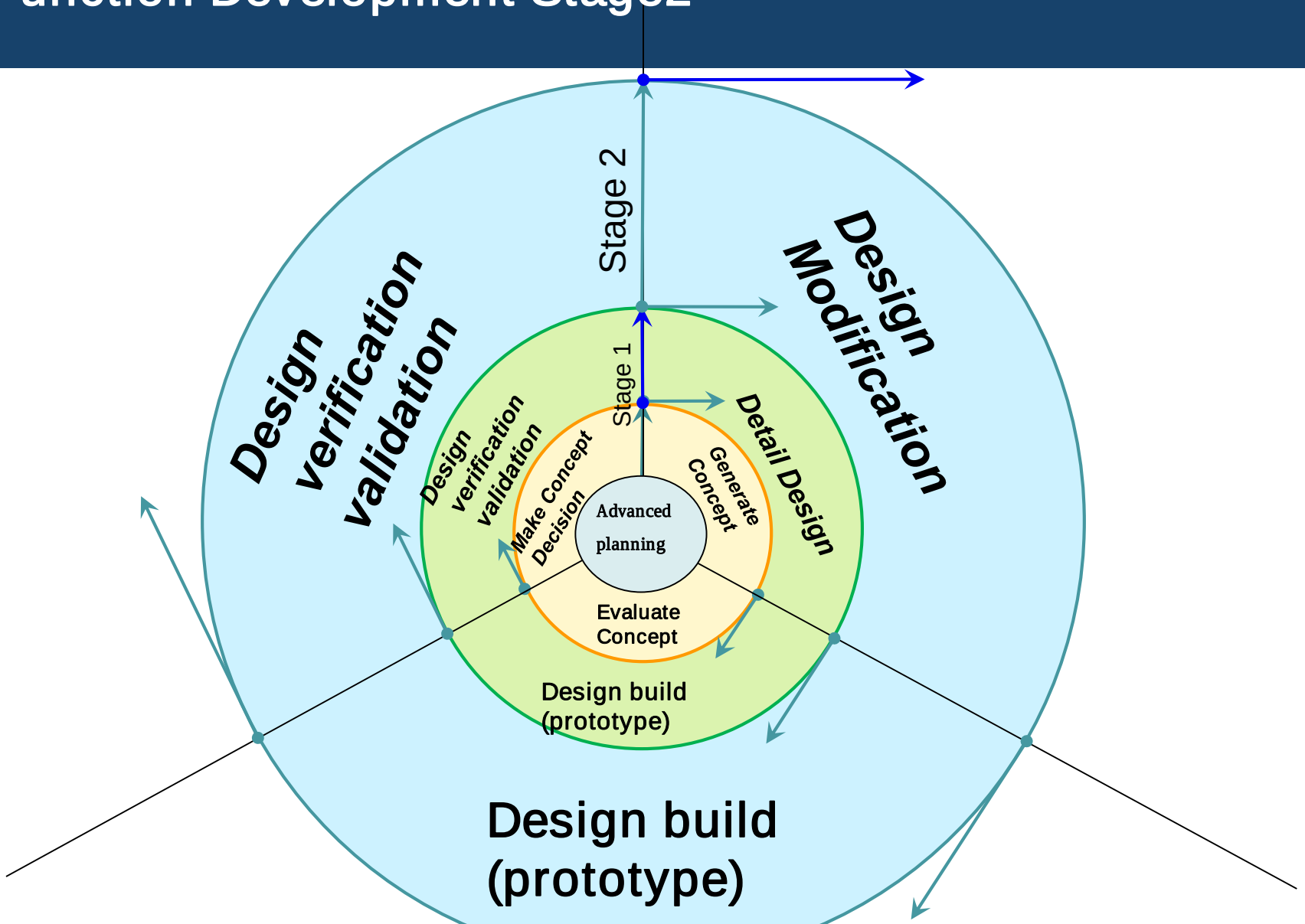
Function Development Stage 2

Stage 2:

Overall Description:

With reference to stage 2, the firstly design is modified according to results previous stage then redesign physical model in order to mature physical model functional and reach ALL targets and satisfy requirements defined in Product and Product Component Requirements.

Function Development Stage2



Function Development Stage 2

Main inputs:

- Combustion Assessment test Report
- Stage 1 Design
- Product and Product Component Requirement
- physical model Target Book

Main outputs:

- Stage 2 2D Drawing
- Stage 2 3D models
- Combustion Development Report
- Targets meet report
- Product and Product Component Requirement and validation Report
- Product and Product Component Requirement
- Validation Plan

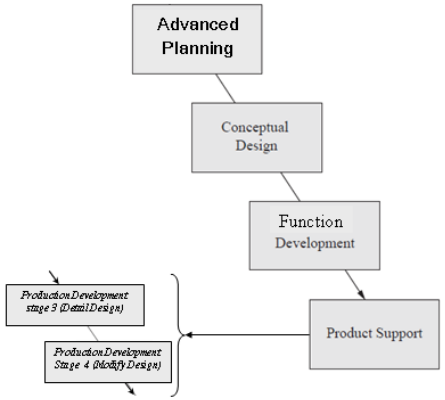
Function Development Stage 2

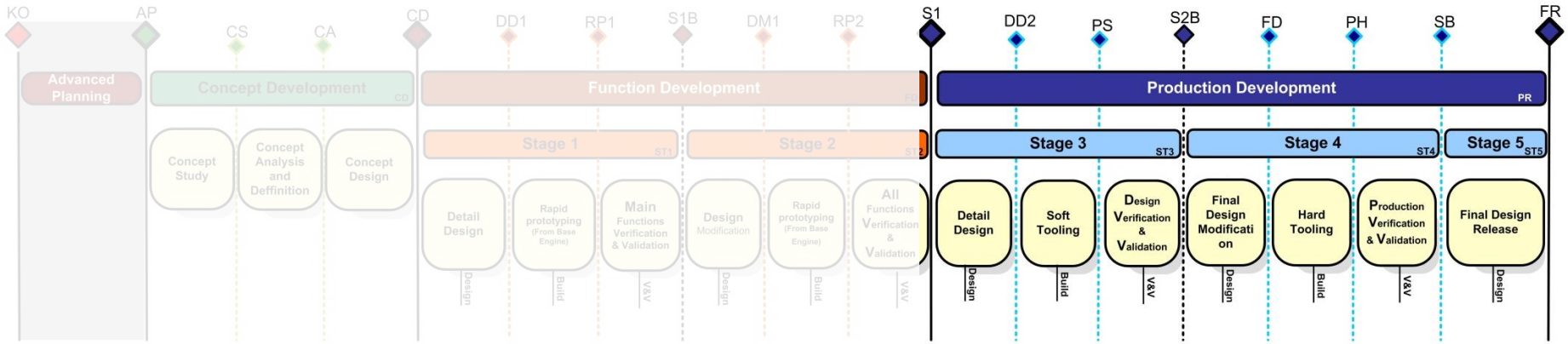
Main Activities:

- physical model Functional Design
- physical model Physical Design
- Combustion Development
- Prepare Product and Product Component Requirement
- Mule physical model Procurement

Production Development stage

Production Development stage





Production Development stage

Inputs:

- » All Concept phase output
- » All Functional development phase output
- » Detail Production Limitations
- » Packaging Limitations
- » CAE Input
- » Production Boundary
- » Knowledge and Experience
- » Benchmarking
- » Cost Target
- » Limitation from designer supplier

Tasks:

- » CAD (Detail 3D Model & 2D Drawing) Top Down Strategy
- » Preparing Test plan
- » Detail Production Analysis
- » Functional integration
- » Design Special Tools
- » Updating BOM (Bill of Materials)
- » Detail Functional Simulation
- » Technology integration
- » Parts Procurement
- » Quality Check
- » System assembly
- » Part & System Validation

Output:

- » CAD (3D Model & 2D Drawing)
- » Test plan
- » Updated CAE Report
- » Updated DFMEA
- » Updated DVP&R
- » Detail Production Analysis Report
- » Packaging Report
- » Updated BOM
- » Updated PDS (Parts & Systems)
- » Quality Check Report
- » Special tools 3D Models and 2D Drawing
- » Assembly Reports
- » Validation and Test Report
- » Preliminary assembly manual and documents

Production Development stage

Purpose of Production Development Stage:

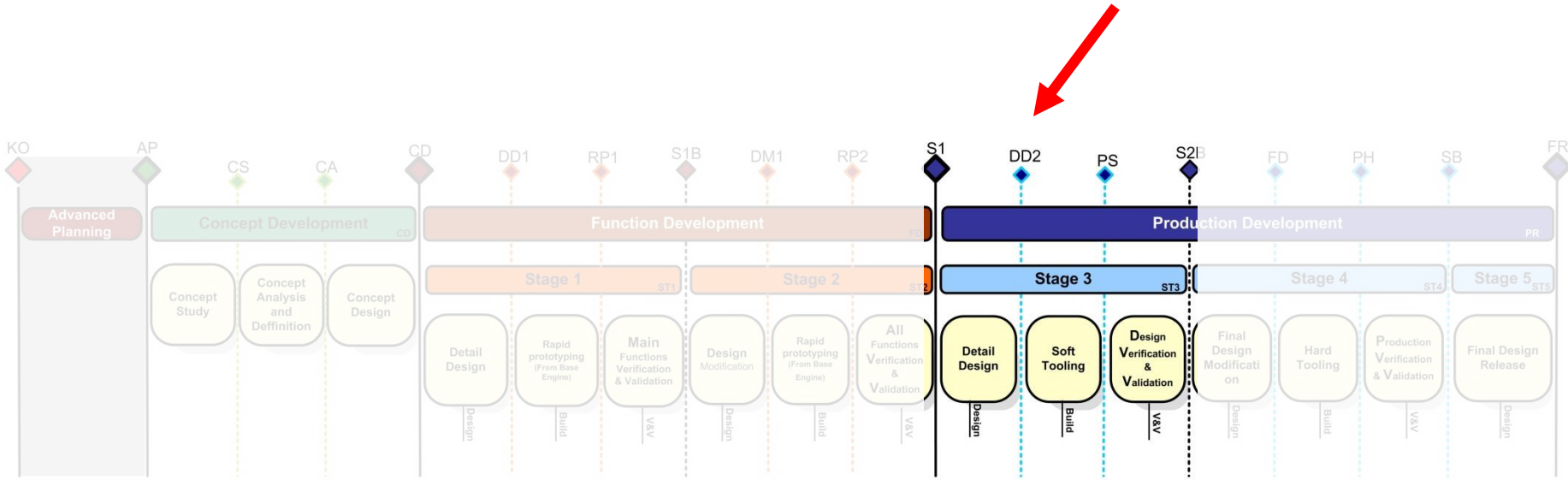
Production development stage with the intention of designing and developing physical model components to mass production. This stage matures product design and specifies production with respect to physical model attributes. Simultaneous physical modeler tools is very important to perform all activity in stage.

Production Development stage

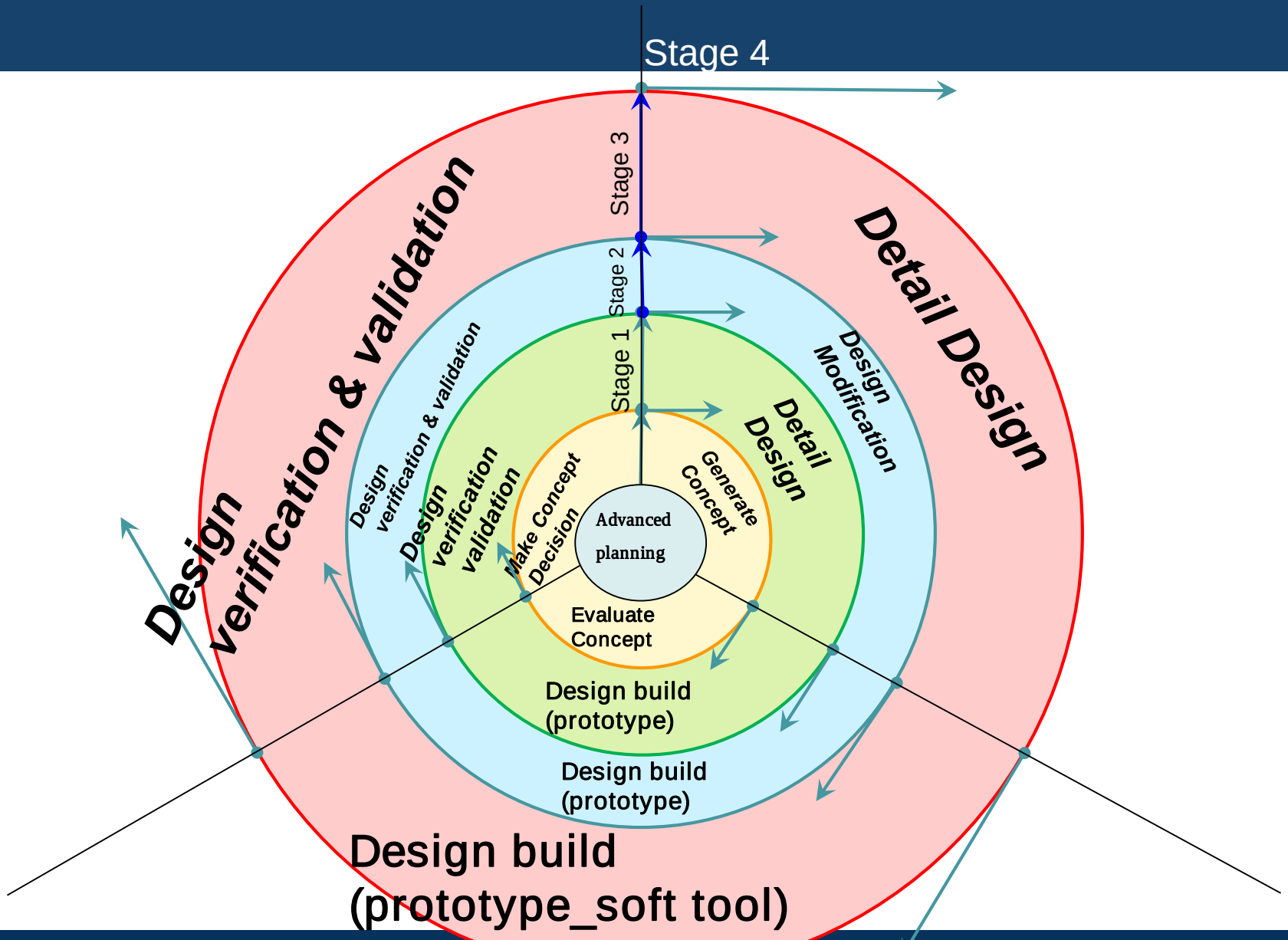
- Overall Description:
  - Production Development Stage will receive a matured physical model from function development stage and delivers product which could be produced in mass Production line. In this stage all casting , machining and assembling features is added to physical model.
  - All physical model activities are performed on basis Product and Product component Requirement and also mass production supplier feed backs.
  - This stage divides into 3 different steps:
    - Stage 3
    - Stage 4
    - Stage 5

Production Development stage3

Production Development stage3



Production Development stage3



Production Development Stage 3

- Purpose of “Stage 3” step:
  - Detailed design of physical model components with respect to production features are performed perfectly in stage3. Needless to say, production features should be parallel with supply chain preparation activities.
- Overall Description:
  - physical models components are built by mass production suppliers, soft tools, in this stage.
  - Verification and Validation tests verifies and validates physical model design and mass production line in Supply chain.

Production Development Stage 3

Main inputs:

- Stage 2 2D Drawing
- Stage 2 3D models
- Combustion Development Report
- Targets meet report
- Product and Product Component Requirement and validation Report
- Mass Production Supplier Feed Backs (During design Phase)

Main Outputs:

- Stage 3 Design Release (2D Drawing , BOM , Etc.)
- First physical model Calibration Release
- Product and Product component Requirement
- Functional Test Report
- Durability Test Report

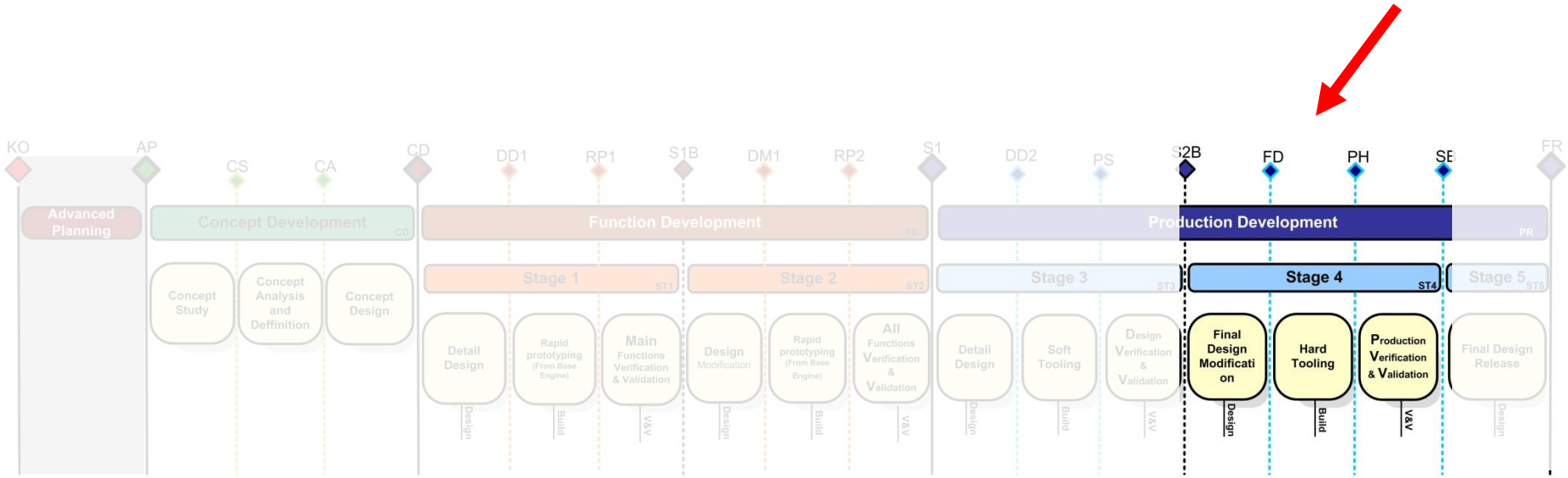
Production Development Stage 3

Main Activities:

- Prepare Product and Product Component Requirement
- physical model Detail Design (Physical)
- physical model Calibration on test bench
- Soft Tool preparation
- Prototype part Preparation
- Functional and Durability tests
- Supplier Handling and Technical Negotiation

Production Development stage 4

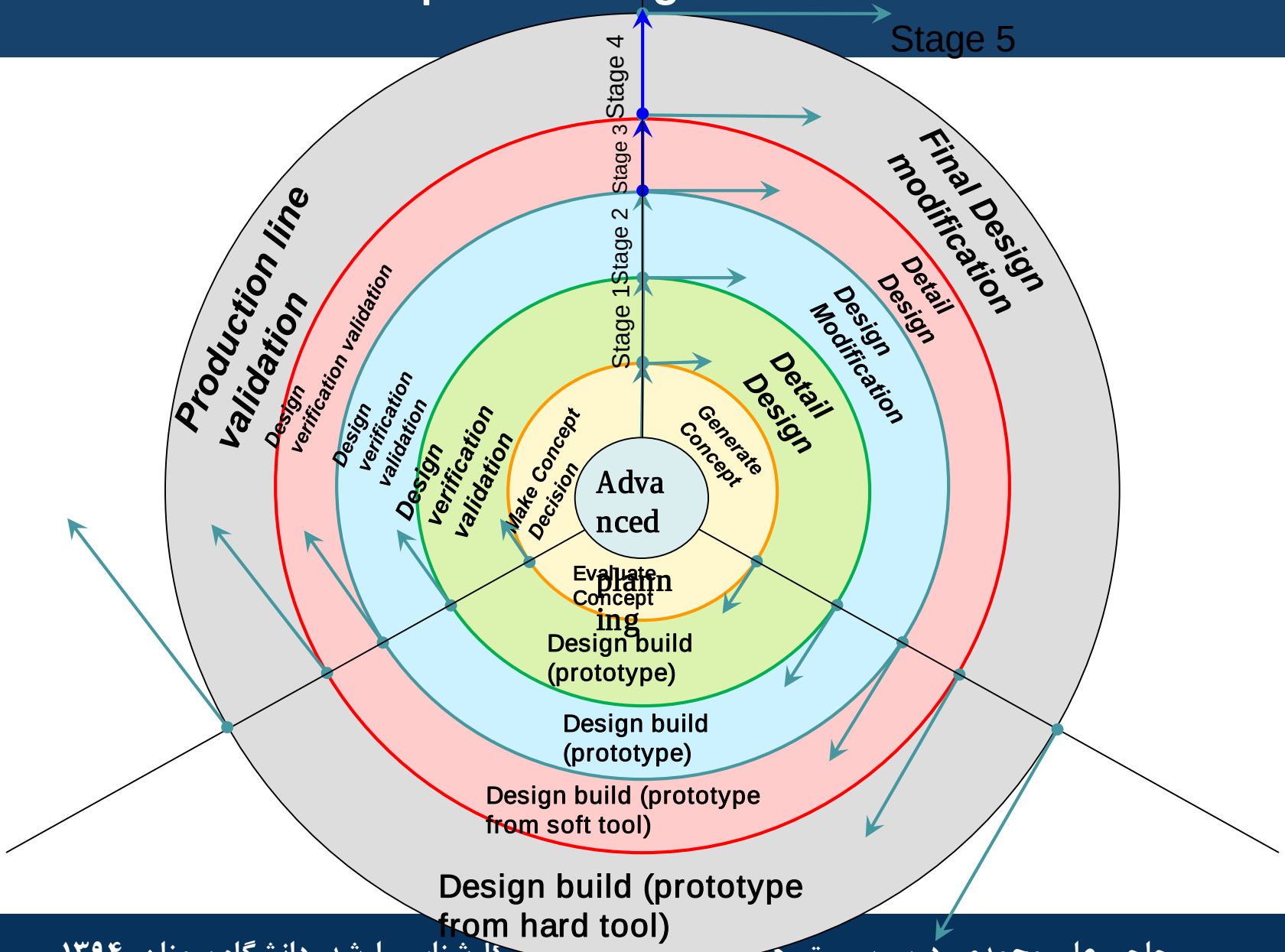
Production Development stage 4



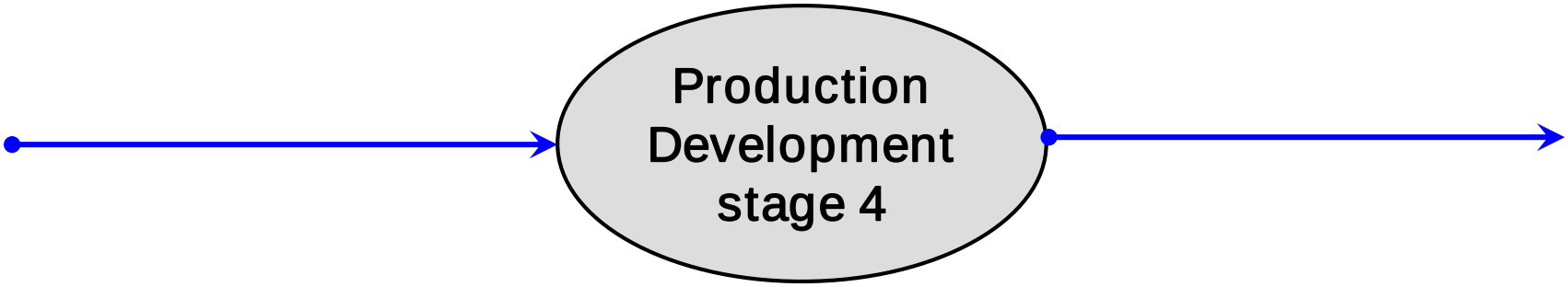
Production Development Stage 4

- Purpose of “Stage 4” step:
  - According to pervious stage, designed physical model is modified in order to mature it in Pre-Series and Production ramp-up.
- Overall Description:
  - physical models components are built by mass production suppliers hard tools and assembly line in this stage.
  - Verification and Validation tests verifies and validates designed physical model , mass production line in Supply chain and assembly line.

Production Development stage 4



Production Development Stage 4



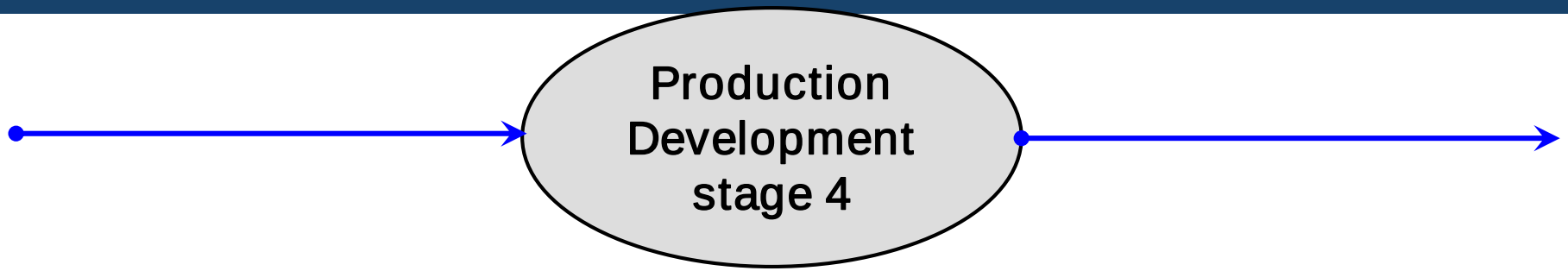
Main inputs:

- Stage 3 2D Drawing
- Stage 3 3D models
- Functional and durability test results
- Targets meet report
- Product and Product Component Requirement and validation Report
- Mass Production Supplier Feed Backs (During design Phase)

Main Outputs:

- Stage 4 Design Release (2D Drawing , BOM , Etc.)
- physical model Calibration Release
- Product and Product component Requirement
- Functional Test Report
- Durability Test Report

Production Development Stage 4

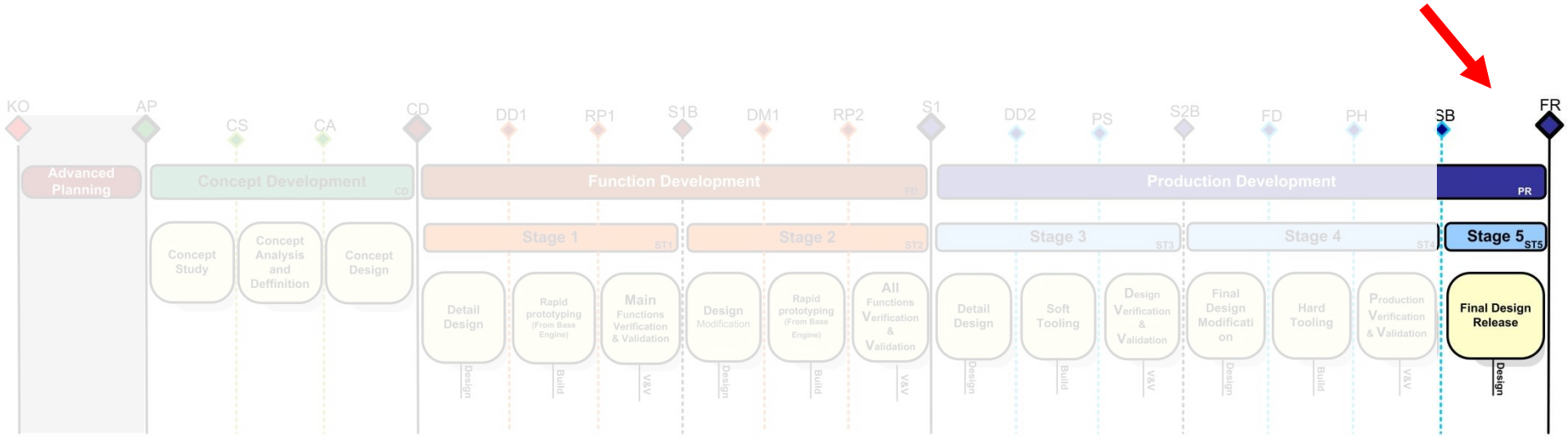


Main Activities:

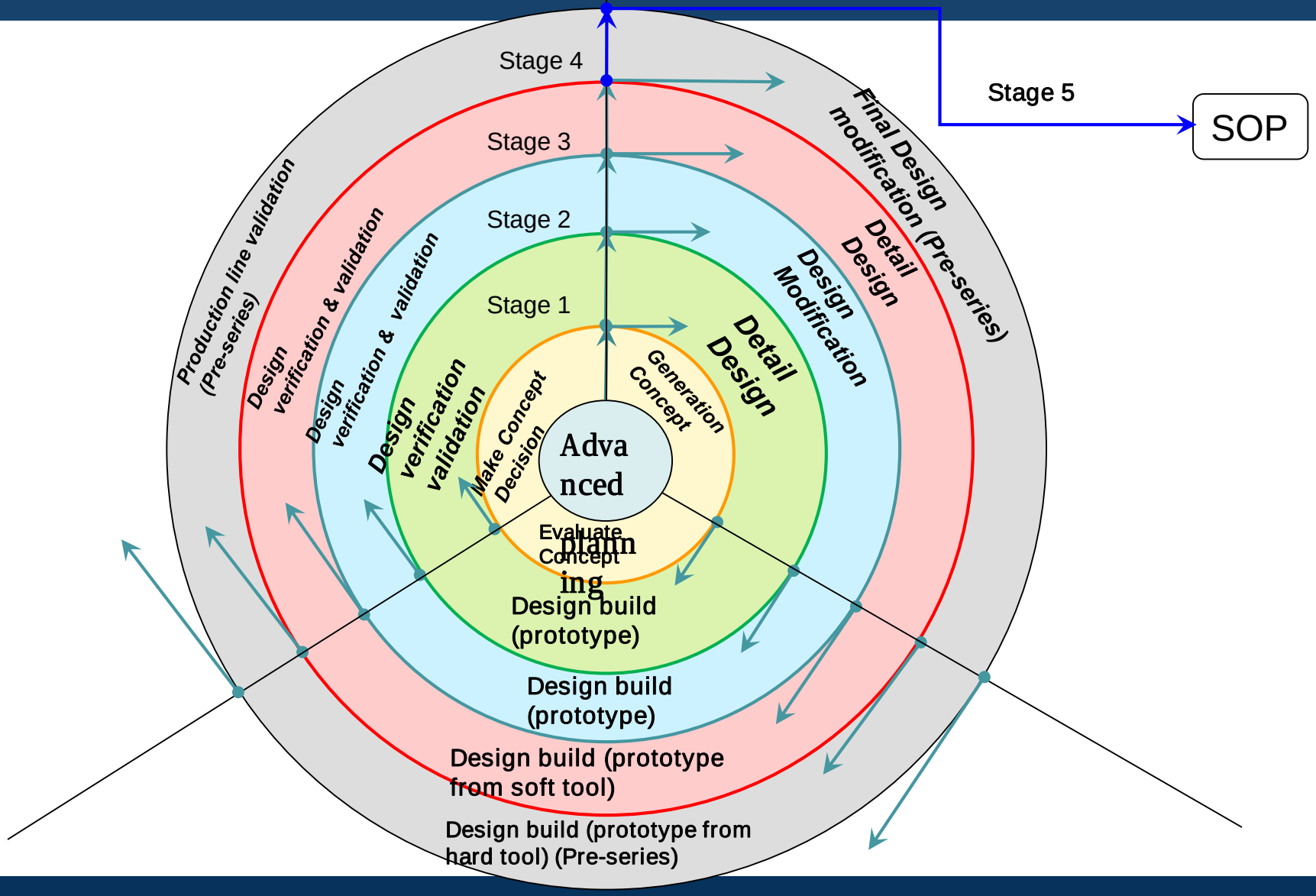
- Prepare Product and Product Component Requirement
- physical model Detail Design (Physical)
- physical model Calibration on test bench
- Vehicle Calibration
- Hard Tool preparation
- Semi - production part Preparation
- Functional and Durability tests
- Supplier Handling and Technical Negotiation
- Assembly line support

Production Development stage 5

Production Development stage 5



Production Development stage 5



Production Development Stage 5

- Purpose of “Stage 5” step:
  - Final Modifications performs on deigned physical model with the purpose of maturing it to start mass production.
- Overall Description:
  - physical models components are built by mass production supplier, hard tools , and assembly line during mass production in this stage
  - Verification and Validation tests verifies and validates designed physical model and mass production line in Supply chain also assembly line in mass production.

Production Development Stage 5

Main inputs:

- Stage 4 2D Drawing
- Stage 4 3D models
- Functional and durability test results
- Targets meet report
- Product and Product Component Requirement G6 validation Report
- Mass Production Supplier Feed Backs (During design Phase)
- Assembly Line Feed backs

Main Outputs:

- Stage 5 Design Release (2D Drawing , BOM , Etc.)
- Final Calibration Release (After a period of mass production)
- Product and Product component Requirement
- Functional Test Report
- Durability Test Report

Production Development Stage 5

Main Activities:

- physical model Detail Design (Physical)
- physical model Calibration on test bench
- Vehicle Calibration
- Hard Tool preparation
- Prepare Product and Product Component Requirement
- Semi - production part Preparation
- Functional and Durability tests
- Supplier Handling and Technical Negotiation
- Assembly line support

Production Development stage 5

Inputs:

- » All Concept phase output
- » All Functional development phase output
- » All Production development phase output
- » Detail Production Limitations
- » CAE Input
- » Production Boundary
- » Knowledge and Experience
- » Benchmarking
- » Limitation from designer supplier

Tasks:

- » CAD (3D/2D Modification)
- » Preparing Test plan
- » Detail Production Analysis
- » Design Special Tools
- » Updating BOM
- » Trouble shooting
- » Technology integration
- » Parts Procurement
- » Quality Check
- » System assembly
- » Assembly Validation
- » Preparing Product Documents
- » Preparing Quality Documents
- » Assembly Line Support
- » Support Supplier
- » Special Tool & Part

Output:

- » Final Release of all documents
- » Special tools 3D Models and 2D Drawing
- » Assembly Reports
- » Validation and Test Report
- » CAD (3D/2D Modification)
- » Product Documents
- » Quality Documents
- » Assembly Line Support
- » Support Supplier
- » Special Tool & Part
- » Quality Support

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