

Productivity and Efficiency improvements at cable manufacturers by model driven solution

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Standard Model for software Solution

Strategy and Decision making

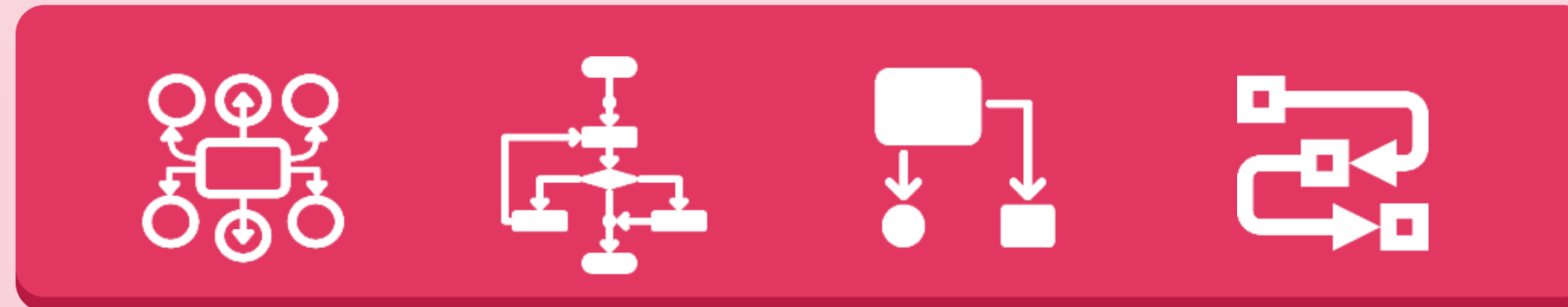


Intelligent Reports

Dashboards



Supervision and Control



Business Model

Process

Flow of Works



Operation and Execution



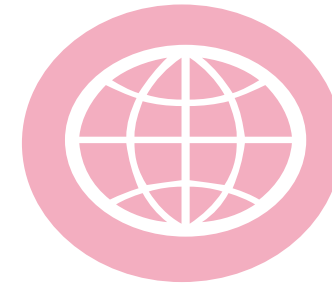
Forms

User Interfaces

Communications

Minimum Requirements of Software Solutions

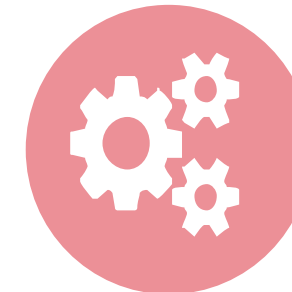
Support Multilingual



Provide necessary tools to build Object Oriented elements



Capable to Integrate to other systems



Powerful programming environment



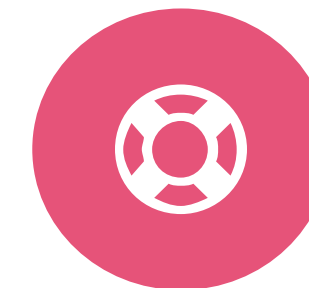
Ensure the Security



Report maker with several outputs



Use modern Method of Process modeling



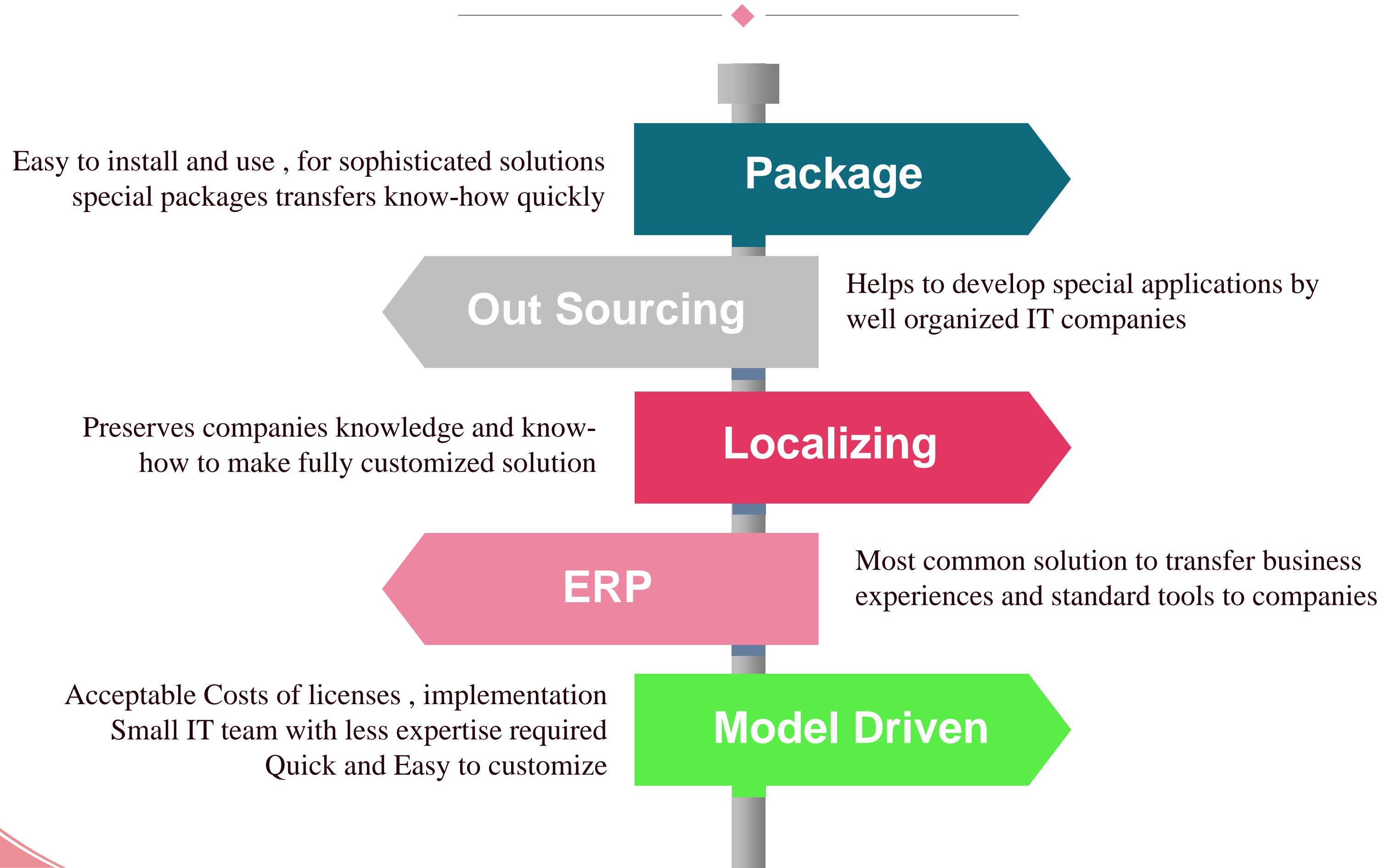
Systematic Supports



Simple and Quick to Develop



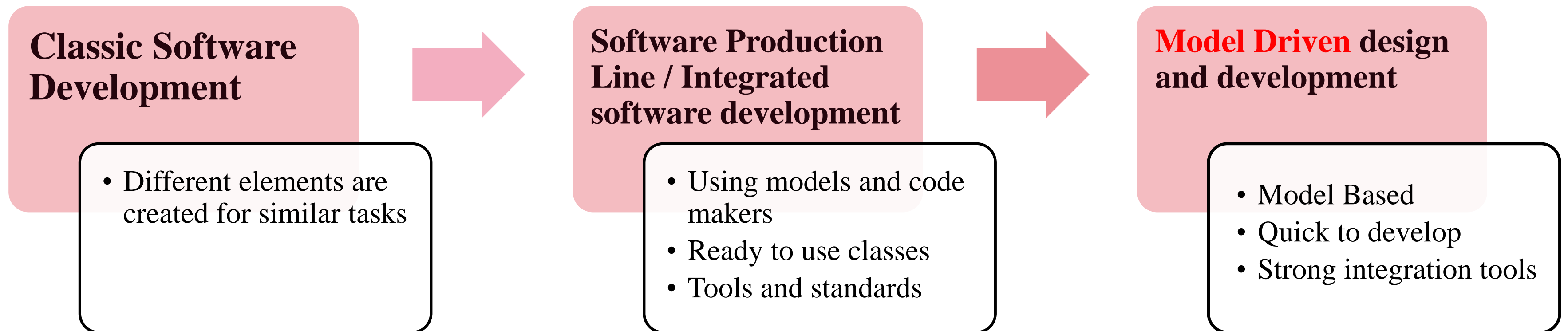
Options for Company's Solution



What's Model Driven Solution ?

A tool that produces integrated , complete software solution for any business

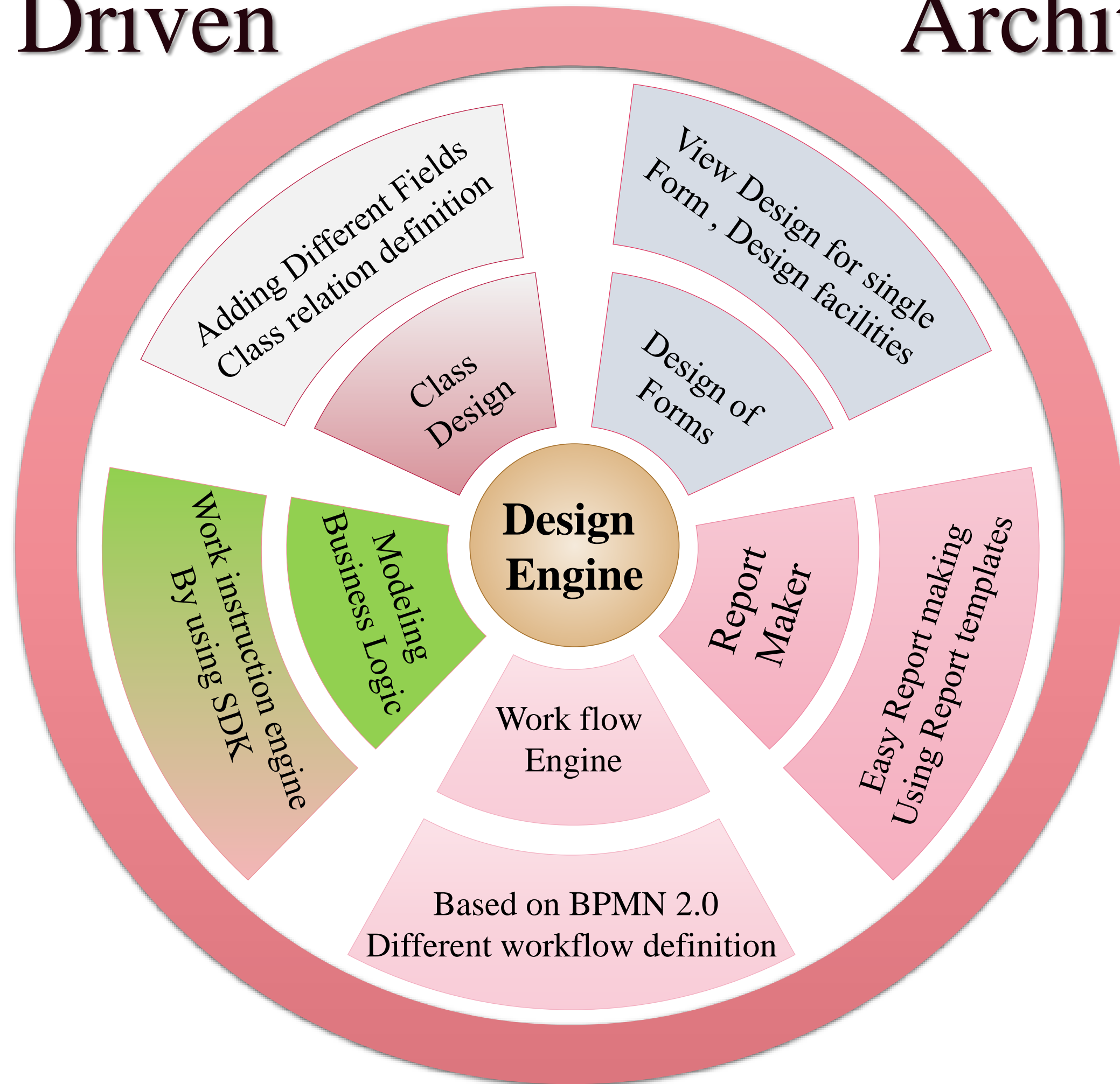
*based on best practice of **Object Oriented Programming***



- **Model Driven Architecture**
 - Less need for hard codes

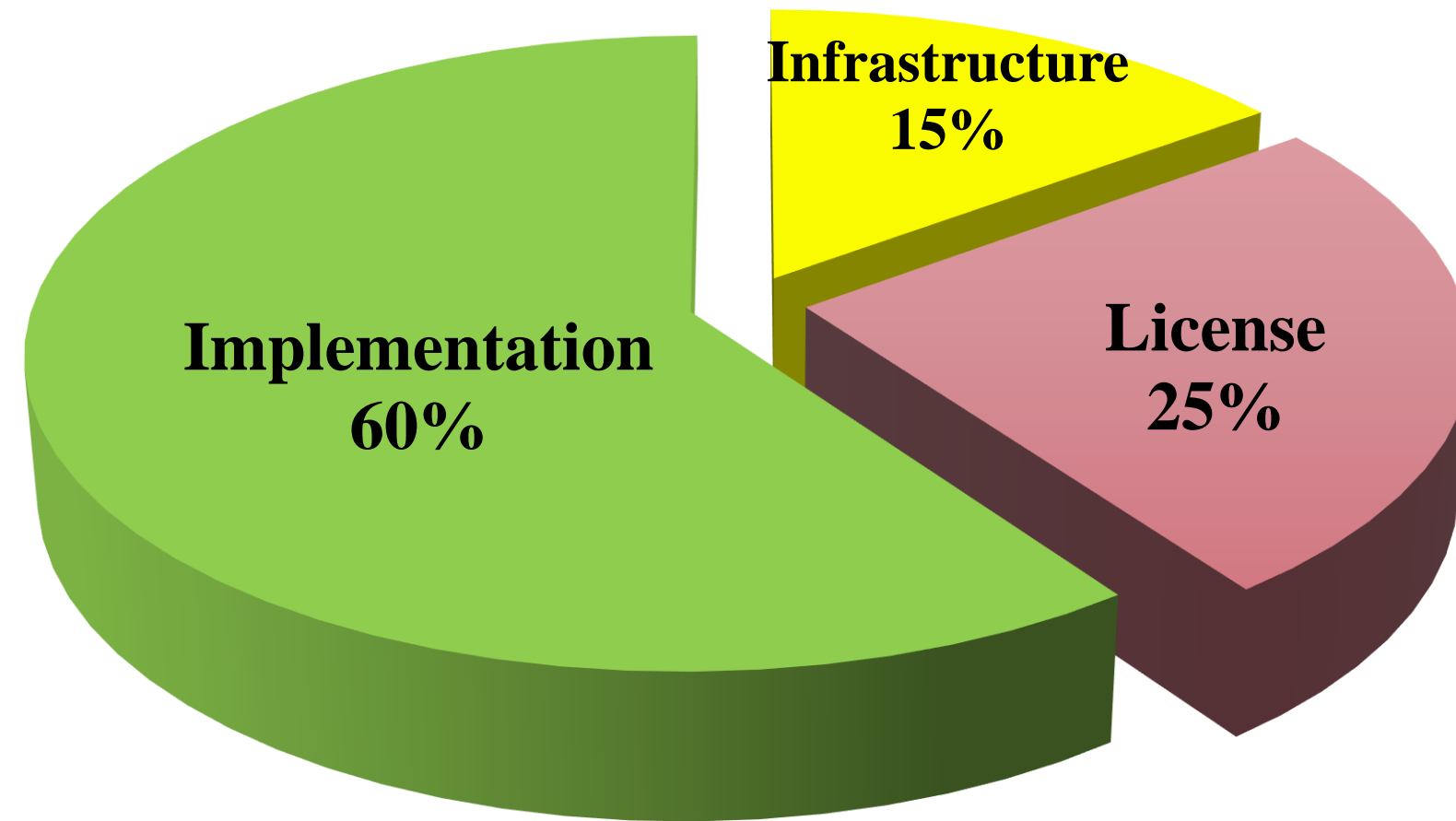
Model Driven

Architecture



Solution's Cost and Risks

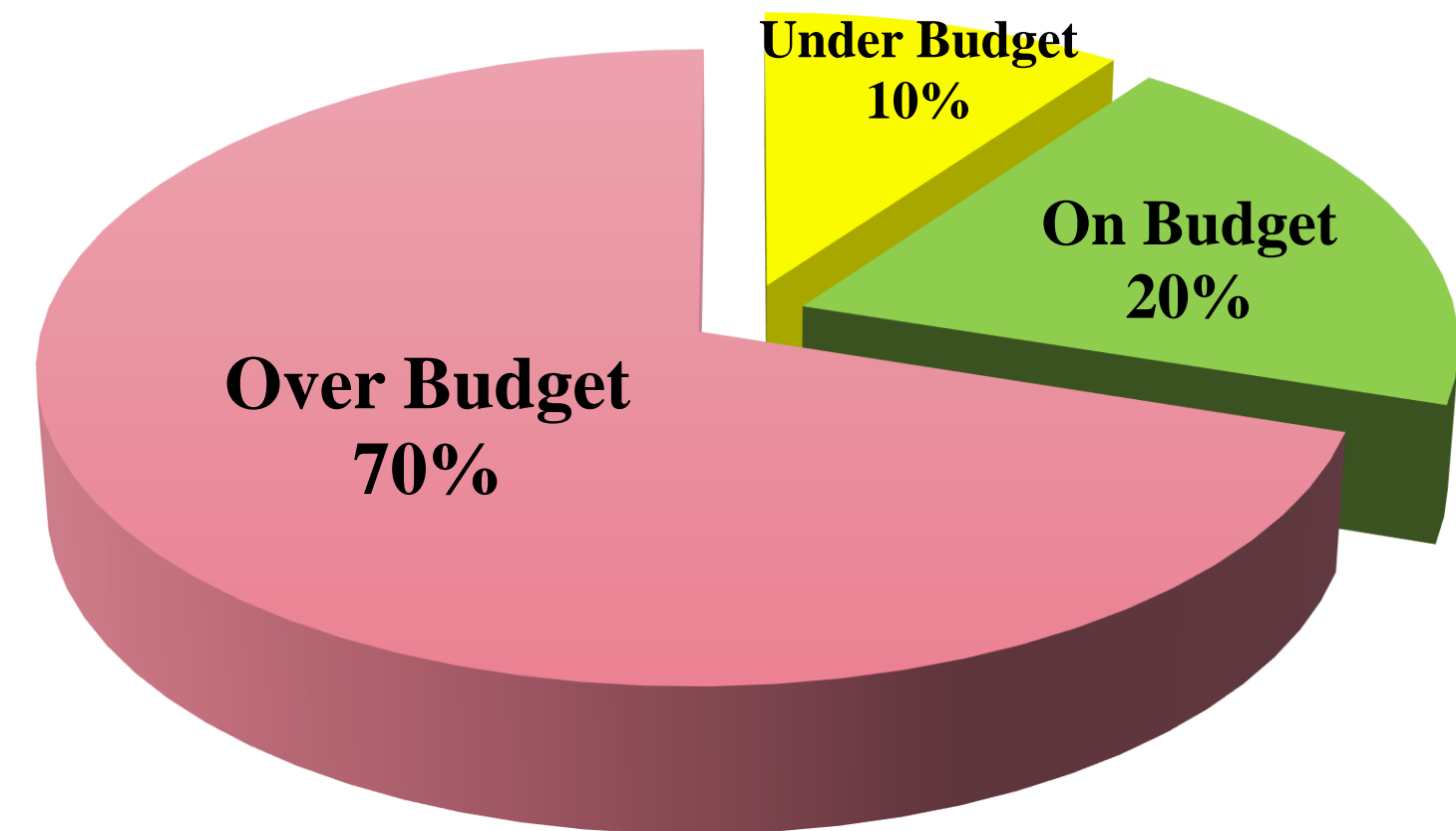
Cost distribution



Implementation process consist of :

- * Business study and analysis
- * Customization
- * Training
- * Test and Debug

Finished Costs

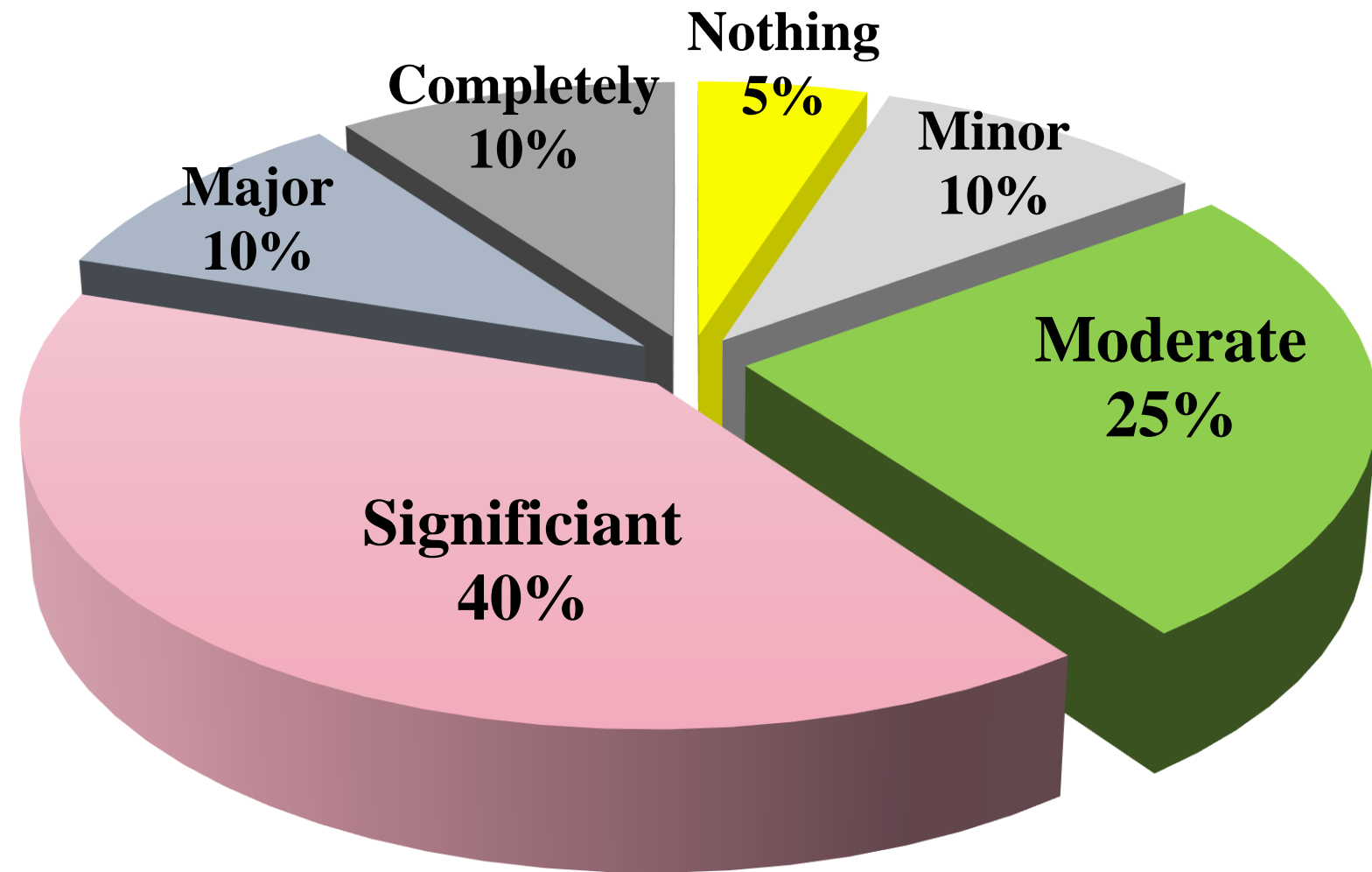


Over Budgeting may be caused by :

- > Unclear and poor business analysis
- > Wrong Customization level
- > Complicated to learn
- > Long time of debug and test

Customization vs Solution implementation

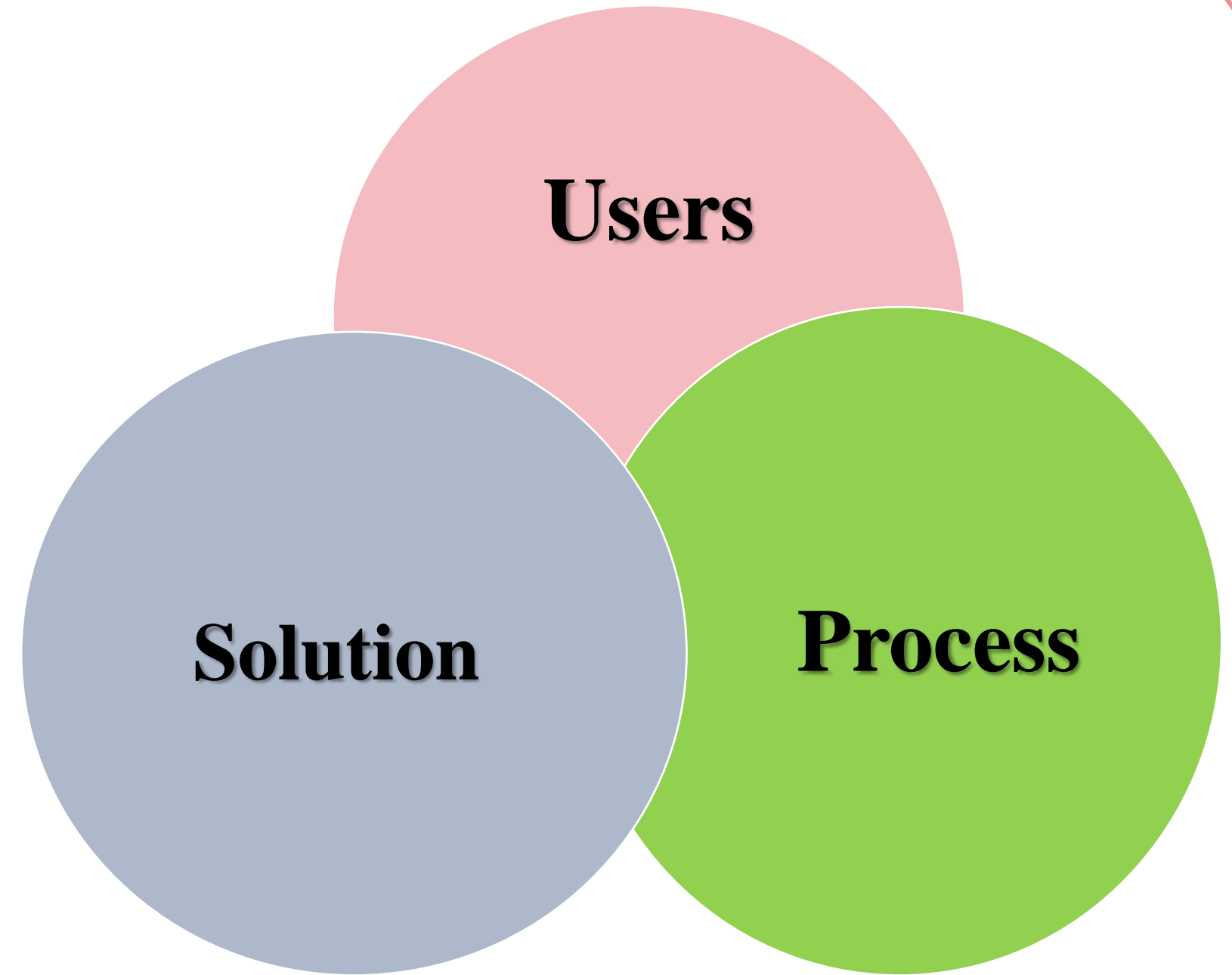
Required Customization



Customization is necessary to adapt solution to requirements but ;

**More Customization ,
More implementation time and cost**

Be careful of Project failure !



We need to consider :

User's best business practice

Process covers the system legacy

Solution implement process

Options for Implementation of Model Driven Solution



1

Develop by Software Company

Advantages : Requires less experts to develop

Disadvantages : Difficult to customize

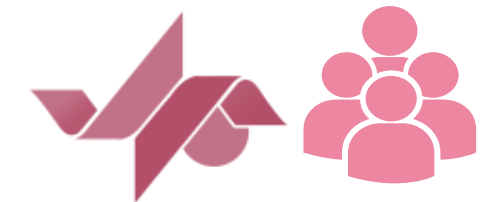
**Acceptable
Performance**

Develop by Client and Software /consulting company

Advantages : Quick to Customize and
knowledge transfer

Disadvantages : Difficult to arrange teams

2



**Average
Performance**



3

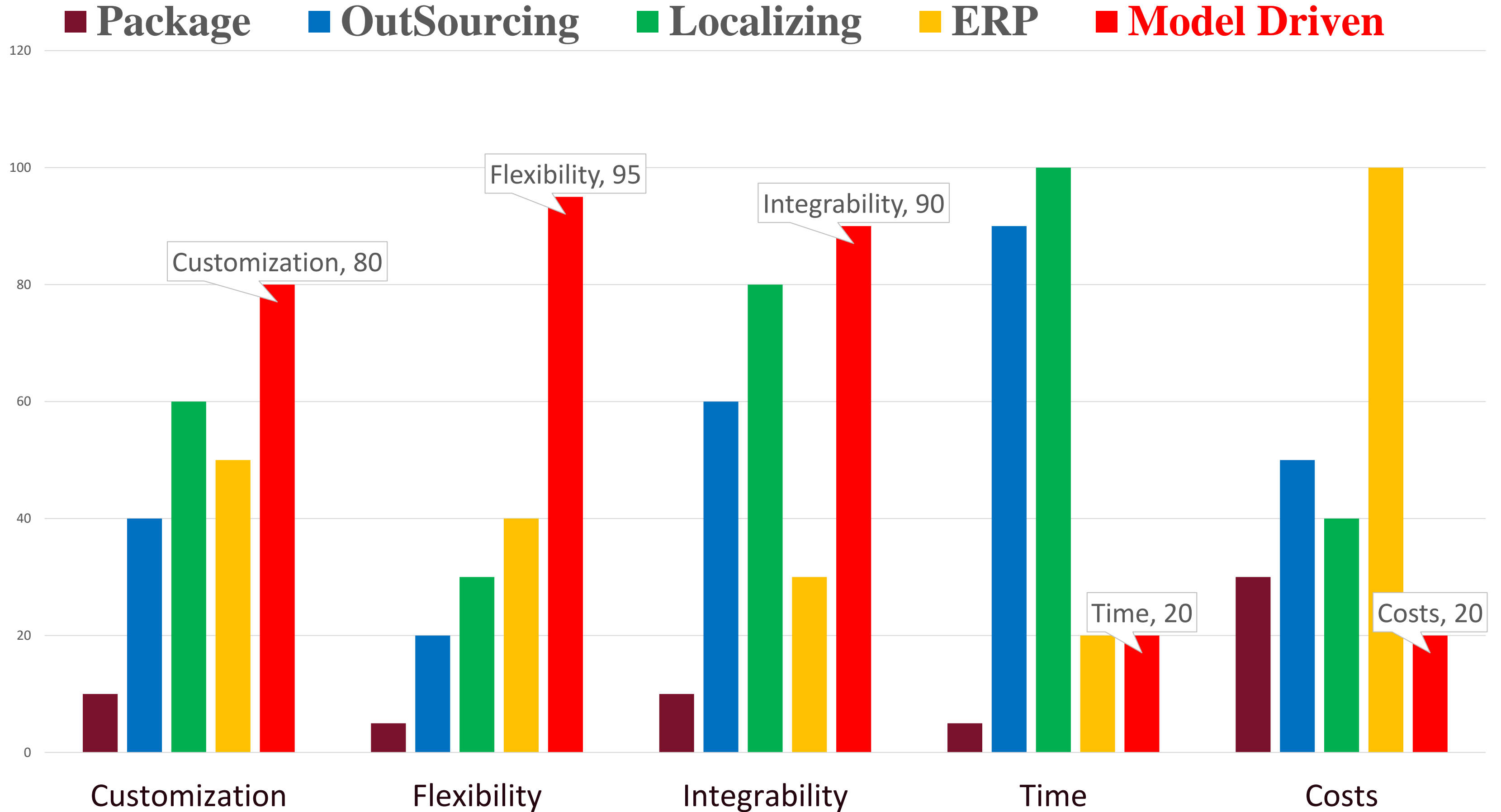
Develop by Client

Advantages : In house development and easy to implement

Disadvantage : Requires time to train experts and Business Modeling

**High
Performance**

Solution's performance comparisons



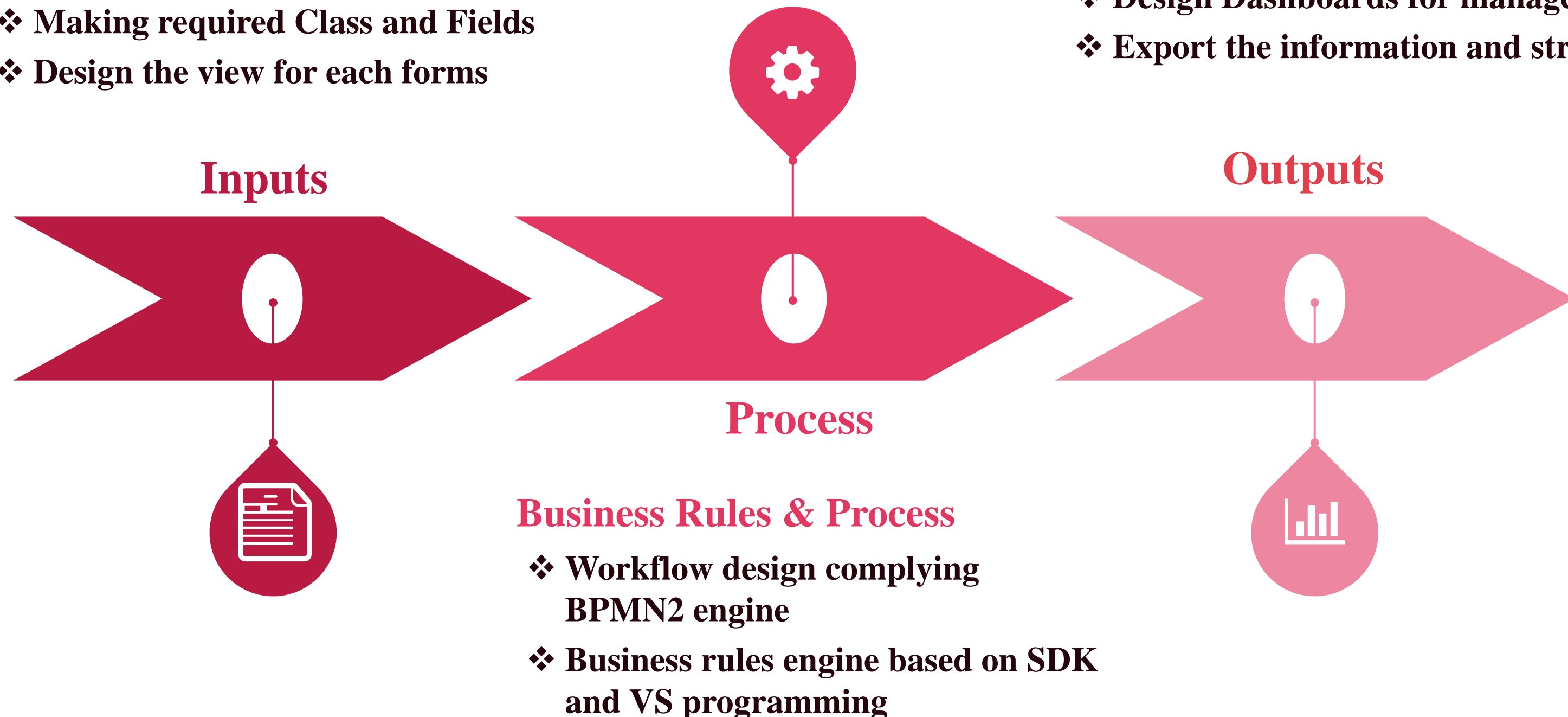
Solution Making approach in Model Driven

Class and Form Definition

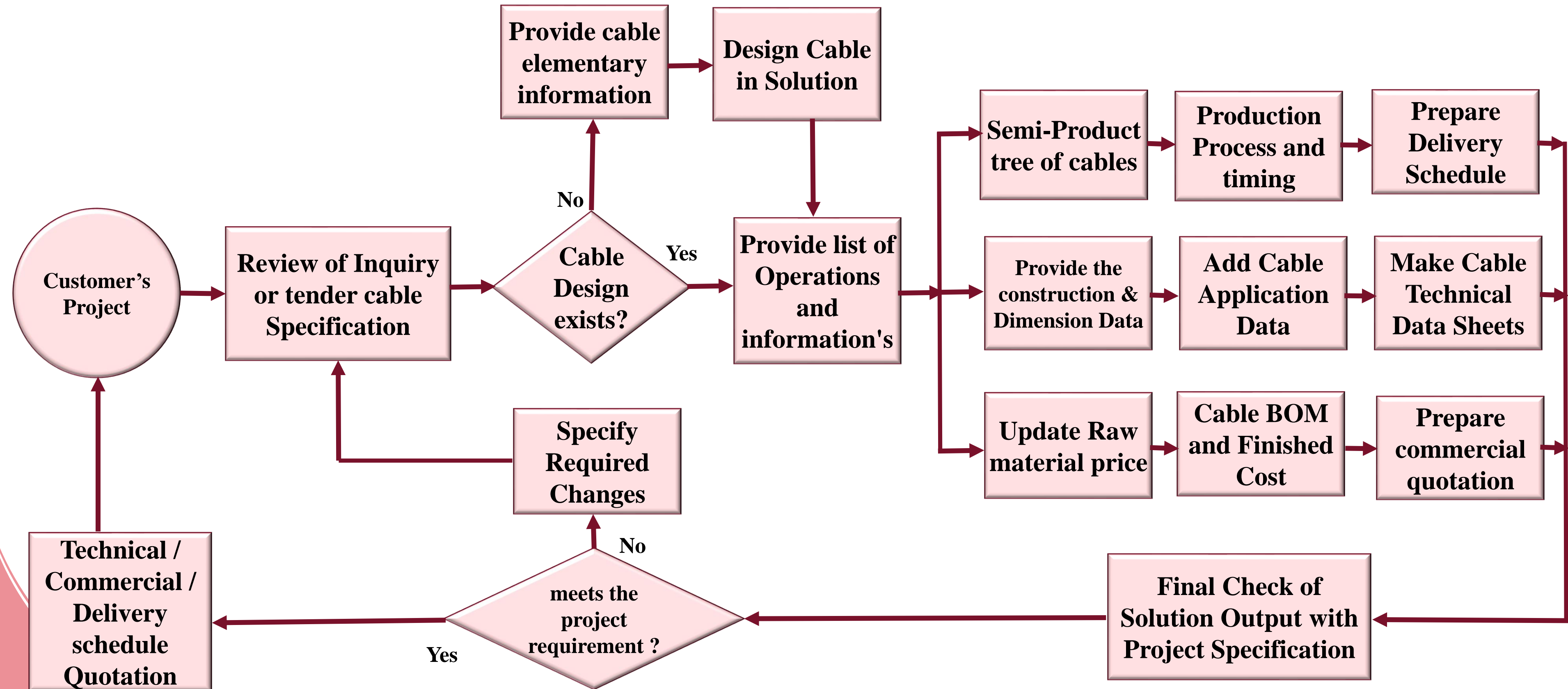
- ❖ Business study and Modeling
- ❖ Making required Class and Fields
- ❖ Design the view for each forms

Reports and Dashboards

- ❖ Design reports
- ❖ Design Dashboards for managers
- ❖ Export the information and structure



Flow Chart of Design & Quotation Process



An Implemented Module



Layer
Type/Name

Layer
Properties

Conductor
Data

Cabling
Elements

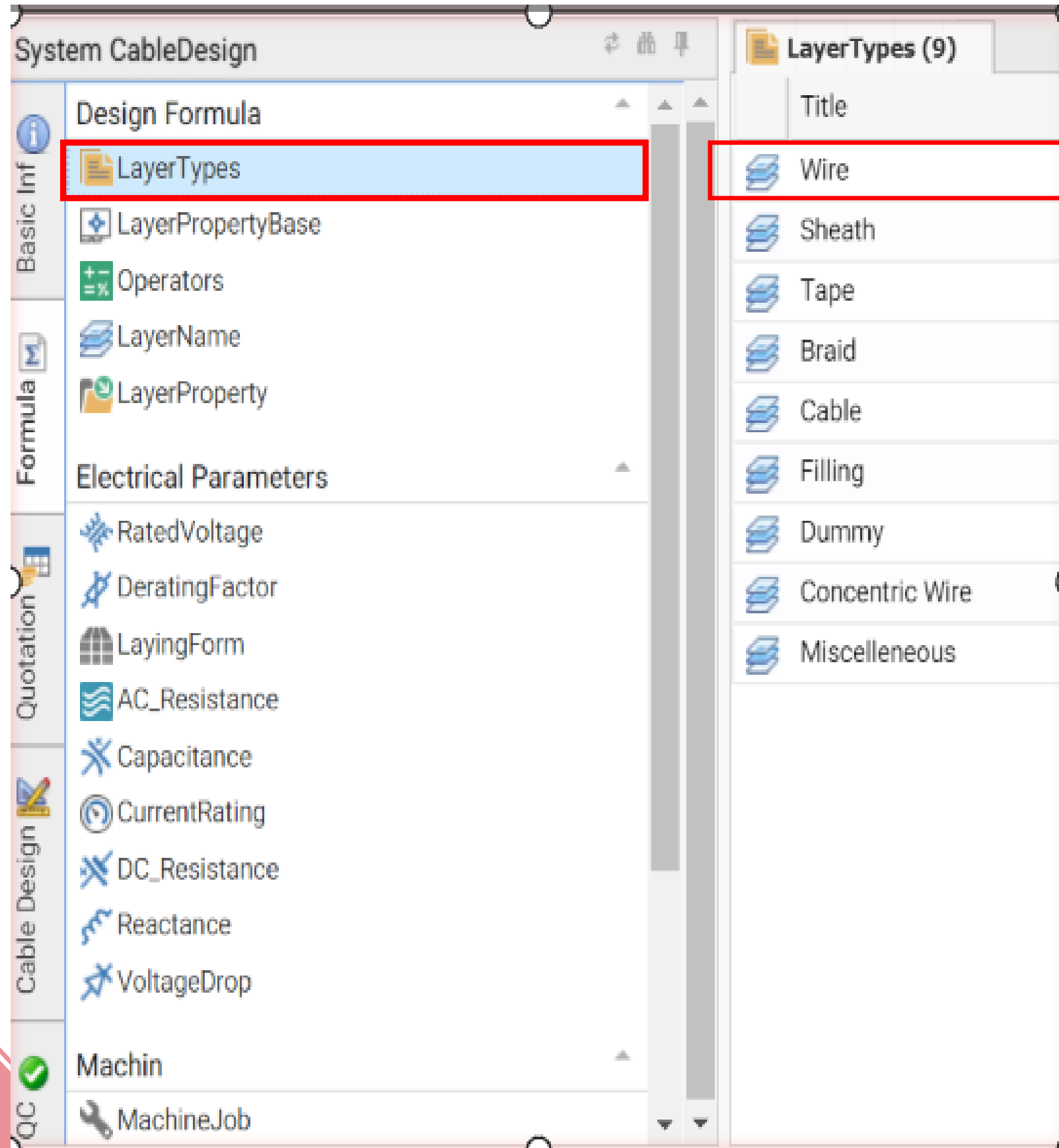
Standard
Application

Coding
Tables

Process
Machinery

Semi
Products

Cable
Design



Cable Design Starts from Layer Definition

Each **Layer type** can be expanded to **Layer Names** as instance

Definitions can be verified or changed as per manufacturer style

Title	Code
BraidArmour	25
BraidScreen	16
WireArmour	26
WireScreen	21
MasterBatch	43
RingMark	42
IDBinder	41
TinCoat	44
MarkingInk	45
RinCord	46



System CableDesign

Design Formula

LayerTypes

LayerPropertyBase

Operators

LayerName

LayerProperty

Electrical Parameters

RatedVoltage

DeratingFactor

LayingForm

AC_Resistance

Capacitance

CurrentRating

DC_Resistance

Reactance

VoltageDrop

LayerPropertyBase (36)

Title

SingleWireDiameter

NumberOfWire

Thickness

LayerDiameter1

LayerDiameter2

NumberOfElements

NumberOfSpindles

NumberOfEnds

TapeWidth

CrossSection

Weight

LayLength1

LayLength2

LayLength3

Page 1 From 2

Each **Layer Type** , **Layer Name** consist of list of properties (or Attributes)

These attributes define the characteristics of each layer and **input** / **output** data of them



System CableDesign

Basic Inf

- Design Formula
- LayerTypes
- LayerPropertyBase
- Operators
- LayerName
- LayerProperty**

Formula

Electrical Parameters

- RatedVoltage
- DeratingFactor
- LayingForm
- AC_Resistance
- Capacitance
- CurrentRating
- DC_Resistance
- Reactance
- VoltageDrop

Quotation

Cable Design

LayerProperty (13)

Wire

Search Clear

Layers	PropertyBase	Formula
fx Wire	Weight	Case When dbo...
fx Wire	LayerDiameter1	
fx Wire	LayerDiameter2	
fx Wire	LayLength1	Case When dbo...
fx Wire	NumberOfWire	
fx Wire	SingleWireDiame...	
fx Wire	CrossSection	
fx Wire	LayLength2	
fx Wire	LayLength3	
fx Wire	LayLength4	

Layer attributes (**properties**) can be determined by input / output parameters or be **calculated by formulas**

fx LayerProperty :Weight

Save and Close Delete

Wire Layers:

AddBeforeTitle Clear All Add Befor Add Current Add Static

AddShapeName Shape: AddLayerName LayerName:

Formula:

```

Case When
  dbo.FPName(@LayerID,'LayerName')='Conductor' then
  (
  Case when  dbo.FPName(@LayerID,'ShapeName') = 'Solid' then
  3.14* Power(dbo.FProprtyValue(@LayerID, 'SingleWireDiameter'),2) *0.25*  dbo.FPName(@LayerID,'SPCW')

  when  dbo.FPName(@LayerID,'ShapeName') = 'Strand' or  dbo.FPName(@LayerID,'ShapeName') = 'Bunch' then
  3.14* dbo.FProprtyValue(@LayerID, 'NumberOfWire') * Power(dbo.FProprtyValue(@LayerID, 'SingleWireDiameter')

  when  dbo.FPName(@LayerID,'ShapeName') = 'Sector100D' or  dbo.FPName(@LayerID,'ShapeName') = 'Sector1
  'Sector60D ' or
  dbo.FPName(@LayerID,'ShapeName') = 'Sector90D' or  dbo.FPName(@LayerID,'ShapeName') = 'Strand-Comp
  then
  0.97* dbo.FProprtyValue(@LayerID, 'CrossSection') *  dbo.FPName(@LayerID,'SpCW')
  else 0
  
```




System CableDesign

Basic Definition

- ConductorShape
- XSection
- ConductorData**

Formula

- Cable Factor
- SectorRadius
- TapeWidth
- Style

Quotation

- ColorCode
- InsulationThickness-IEC60502
- BaseMaterial
- ConductorClass

Cable Design

- MainGroupOfMaterial
- SubGroupOfMaterial
- Material

ConductorData (24)

Shape	WireDiam...	WireNum...
Strand	0.3	7
Strand	0.37	7
Strand	0.43	7
Strand	0.53	7
Strand	0.67	7
Strand	0.85	7
Strand	1.04	7
Strand	1.35	7
Strand	1.7	7
Strand	1.78	19

ConductorClass (4)

ConductorClass
1
2
6
5

ConductorShape (14)

Title	Code
Solid	1
Bunch	2
Bunch-Strand	3
Strand	4
Strand-Compres...	5
Sector60D	6
Sector90D	7
Sector100D	8
Sector120D	9
Sector180D	10
MultiConductor	11
Super-Bunch	12
Milliken	13
Srctor72D	14

XSection (108)

XSection
0.72
0.75
0.8
0.85
1
1.1
1.2
1.3
1.4
1.43
1.5
1.54
1.58
1.8

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Conductor is most important and inner layer of cables.

We classify conductors to make them **modular** both in Design and in Fabrication

Conductor Data classification can be :

Shape

Class

Cross section



System CableDesign

Basic Inf

- Basic Definition
- ConductorShape
- XSection
- ConductorData
- Cable Factor**

Formula

- SectorRadius
- TapeWidth
- Style**

Quotation

- ColorCode
- InsulationThickness-IEC60502
- BaseMaterial
- ConductorClass

Cable Design

- Material
 - MainGroupOfMaterial
 - SubGroupOfMaterial
 - Material

Style (10)

Title
MultiPair
MultiTriple
MultiQuad
Dual-Dimension
OverLap30
GapAndOverlap
OpenHelix
MultiCore
MultiPair-PIMF
MultiTriple-TIMF

Insulated conductor can be assembled in Different styles :

Multi-Core
Multi-Pair
Multi-Triple,
....

Cabling configuration cable be defined or designed once and used many times

Cable Factor (100)			
ElementNO ▲	Factor	Config	
5	2.7	f1+5	
6	3	f1+6	
7	3	1+6	
8	3.6	f+8	
9	3.62	(1+f1)+8	
10	4	2+8	
11	4.15	(2+f1)+9	
12	4.15	3+9	
13	4.41	(3+f1)+10	
14	4.41	4+10	
15	4.7	f1+(4+f2)+11	
16	4.7	f1+5+11	
17	5	f1+(5+f1)+12	

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System CableDesign

InsulationThickness-IEC60502 (456)

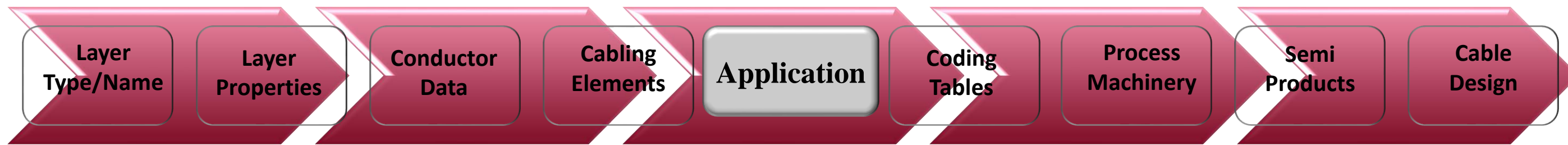
Xsection	InsulationThickness
1.5	0.8
2.5	0.8
4	1
6	1
10	1
16	1
25	1.2
35	1.2
50	1.4
70	1.4
95	1.6
120	1.6
150	1.8
185	2
240	2.2
300	2.4

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To facilitate the Design process and avoid user mistakes , **procedures** and **reference tables** of applicable standards can be defined and linked to other Classes.

Reference tables and procedures (like Fictitious diameter calculation of IEC 60502-1) can help to develop related and similar products





System CableDesign

Electrical Parameters

- RatedVoltage
- DeratingFactor
- LayingForm
- AC_Resistance
- Capacitance
- CurrentRating
- DC_Resistance**
- Reactance
- VoltageDrop

Machin

- MachineJob
- Machines

Process

- Process

DC_Resistance (290)	
XSection	DCResistance
0.5	36
0.75	24.5
1	18.1
1.5	12.1
2.5	7.41
4	4.61
6	3.08
10	1.83
16	1.15
25	0.727
35	0.524
50	0.387
70	0.268
95	0.193

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Application data of each cable can be used both in technical datasheet and in Quality Control test and evaluation.

These parameters are defined once , then will be linked to many cables having same properties in basic elements like conductor size , shape , ...

Application data can be Electrical , Mechanical , Laying ,... such as

- Rated Voltage
- Derating factors
- AC and DC resistance
- Current carrying capacity
- Reactance
- Capacitance
- Voltage Drop ,....



Design Process has two major input /output elements.

RAW material (input)
Finished PRODUCT (output)

Proper coding system can help classification and recall of raw material and product list.

We can support both **traditional coding system** by meaningful or semi-meaningful figures
Or
Sequential coding system , defined and distinguished by attributes



A **process** is defined as a specific workstation in manufacturing sequence

A process consists of a **workgroup** of machines doing same required work , but with different **priority** , cost , ...

Process classification can be very helpful to draw production flow diagram and makes cable construction design practicable



System CableDesign

Basic Inf

- Electrical Parameters
 - RatedVoltage
 - DeratingFactor
 - LayingForm

Formula

- AC_Resistance
- Capacitance
- CurrentRating
- DC_Resistance
- Reactance
- VoltageDrop

Quotation

Machin

- MachineJob**
- Machines

Cable Design

- Process
 - Process
 - Process Tree
 - MachineForProcess

QC

MachineJob (27)

Title
Fine-Drawing
Medium-Drawing
ROD-Drawing
Insulating Extruder
General Extruder
Sheathing Extruder
Fine-Buncher/Twiner
Buncher
Fine-Buncher
Buncher/Cabler
Twiner
Cabling-Armouring
Cabler-Buncher
Tele-Cabler
Taper
Taper-TeleCabler

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Machines paly roles in each process due to their capabilities and limitation.

Machines **jobs** are intermediate link of Process and Machines list

Machines **performances** reflected to process and finally each process for specific job gives us **production time** and **cost**



Semiproducts are essential building bricks of any product's construction (like raw material)

System CableDesign

Basic Inf

- Design
 - Cable
- Production
 - SemiProduct
 - SemiProduct tree**
- Drawing
 - CordinationXY
 - DummyCordinationXY

Formula

Quotation

Cable Design

SemiProduct (211) | **SemiProduct tree (96)**

Wire LayerType: Copper Material:

Search Clear

- 1000054-Conductor(Wire) - Copper (Solid) 1x0.45 mm
- 1000055-Conductor(Wire) - Copper (Solid) 1x0.43 mm
- 1000056-Conductor(Wire) - Copper (Solid) 1x0.4 mm
- 1000057-Conductor(Wire) - Copper (Solid) 1x0.37 mm**
- 1000031-Conductor(Wire) - Copper (Solid) 1x1.78 mm
- 1000001-Conductor(Wire) - Copper (Solid) 1x8 mm
- 1000058-Conductor(Wire) - Copper (Solid) 1x0.32 mm
- 1000059-Conductor(Wire) - Copper (Solid) 1x0.25 mm
- 1000060-Conductor(Wire) - Copper (Solid) 1x0.3 mm
- 1000061-Conductor(Wire) - Copper (Solid) 1x0.15 mm
- 1000062-Conductor(Wire) - Copper (Solid) 1x0.2 mm

Cable :CableCode : 100100 - NY-Y-O 4x1.5 rm BS Color Code

Save and Close | Calculate Property | Make Similar | Manufacturer

100100 CableCode: RevisionNO:
NY-Y-O CableName: 4x1.5 rm BS Color Code CableSize:

Design | **Tree Of Production** | FormulDrawing | PictureOfProduct | Process

Refresh

- 1000098-Jacket(Sheath) - PVC 3100 - Natural - 1.8 mm
- 1000097-InnerJacket(Sheath) - PVC 4100 - Natural - 0.6 mm
- 1000092-Cabling(Cable) - 4 - MultiCore**
- 1000093-Insulation(Sheath) - PVC 2100 - Black - 0.8 mm
- 1000091-Insulation(Sheath) - PVC 2100 - Natural - 0.8 mm
- 1000066-Conductor(Wire) - Copper (Strand) 7x0.53 mm
- 1000052-Conductor(Wire) - Copper (Solid) 1x0.53 mm
- 1000018-Conductor(Wire) - Copper (Solid) 1x2.4 mm
- 1000001-Conductor(Wire) - Copper (Solid) 1x8 mm
- 1000094-Insulation(Sheath) - PVC 2100 - Blue - 0.8 mm
- 1000095-Insulation(Sheath) - PVC 2100 - Red - 0.8 mm
- 1000096-Insulation(Sheath) - PVC 2100 - Yellow - 0.8 mm

Semiproducts tree shows the product **fabrication flow diagram**



Most common cable design procedure starts from **Construction design**

Cable : CableCode : 100100 - NYY-O 4x1.5 rm BS Color Code

Save and Close | Calculate Property | Make Similar | Manufacturer Inf

100100 CableCode: RevisionNO:
 NYY-O CableName: 4x1.5 rm BS Color Code CableSize:

Design | Tree Of Prduction | FormulDrawing | PictureOfProduct | Process

Row	LayerName	LayerTypes	Shape	Material	DiameterUnder
5	Conductor	Wire	Strand	Copper	
10	Insulation	Sheath		PVC 2100	1.59
15	Cabling	Cable			3.19
20	InnerJacket	Sheath		PVC 4100	7.69
25	Jacket	Sheath		PVC 3100	8.89

LayersOfCable : Sheath: CableCode : 100100 - NYY-O 4x1.5 rm BS Color Code

Save and Close | Delete | List Properties | Calculate Layer Property

10 Row: Sheath LayerTypes:* Insulation

Property Of Layer | SemiProduct | Identification | Drawing | Process

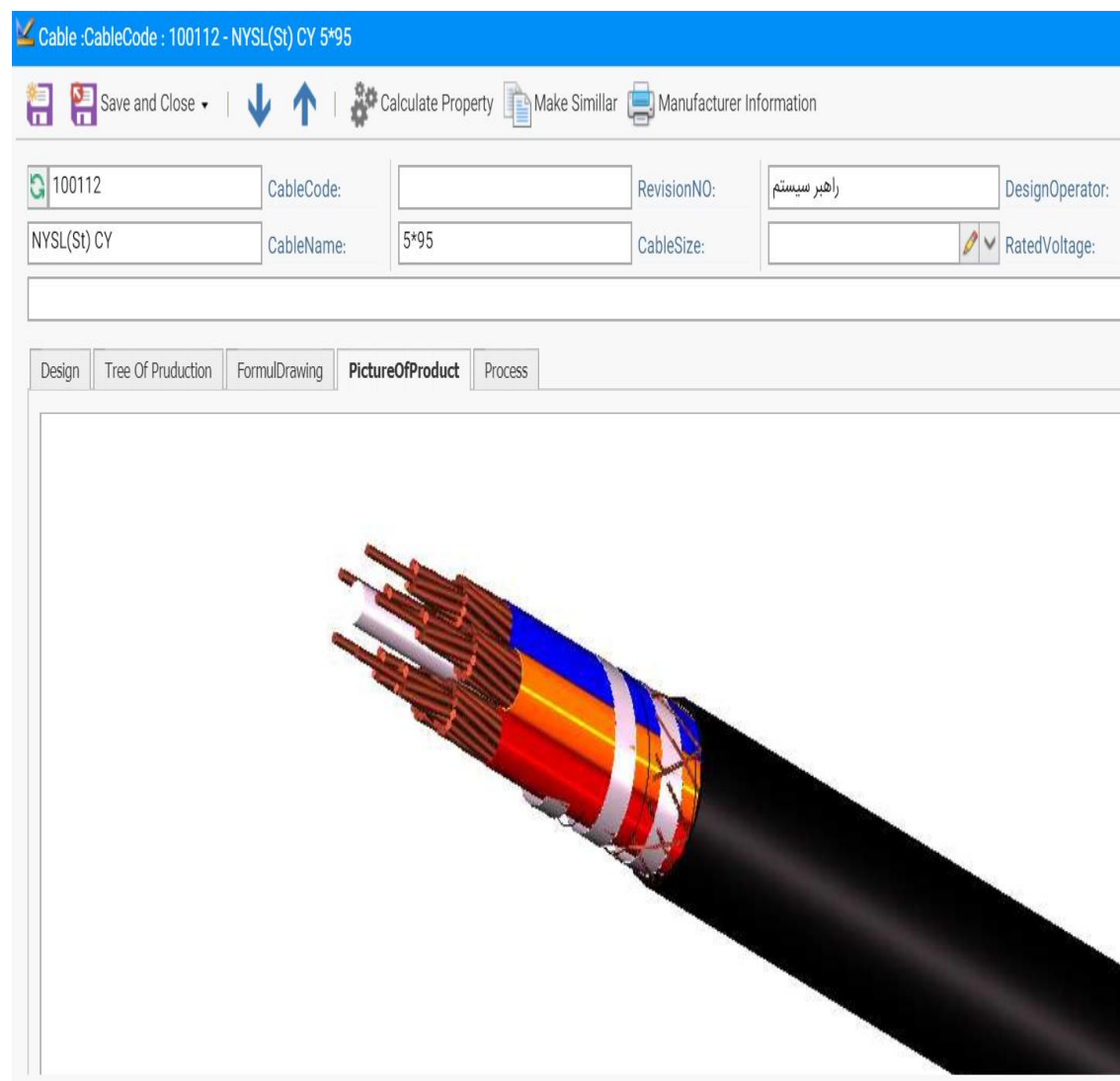
Property	Value
LayerCount	1
LayerDiameter1	3.19
LayerDiameter2	0
Thickness	0.8
Weight	9.023

Design starts from layer selection , **input attributes** , get **output** attributes ,..... Then assign the process and machinery to each layer or combination of them.

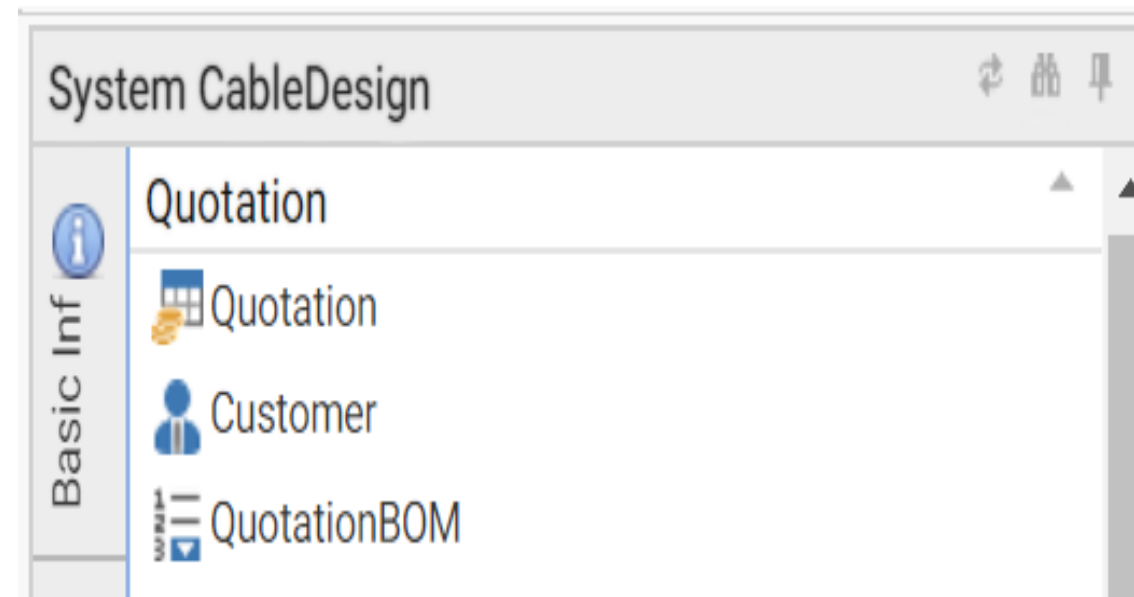


Next Module ?

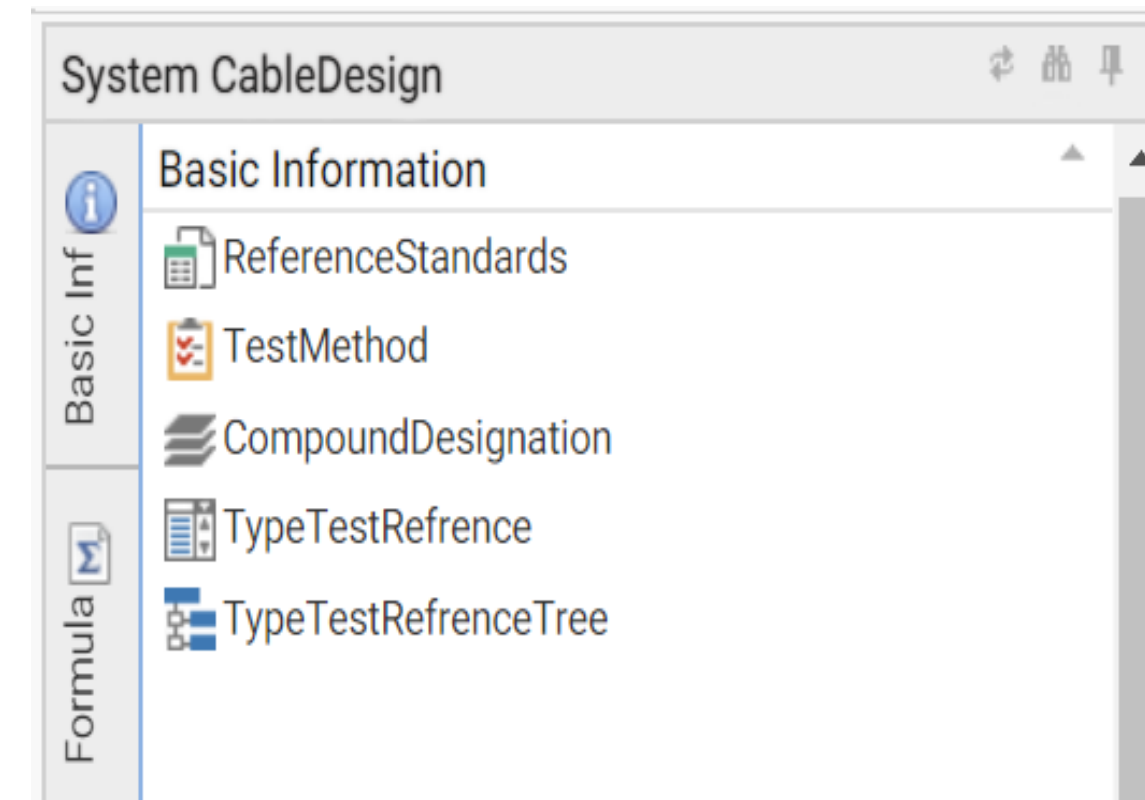
Cable 2D or 3D Drawing



Cable list and Quotation

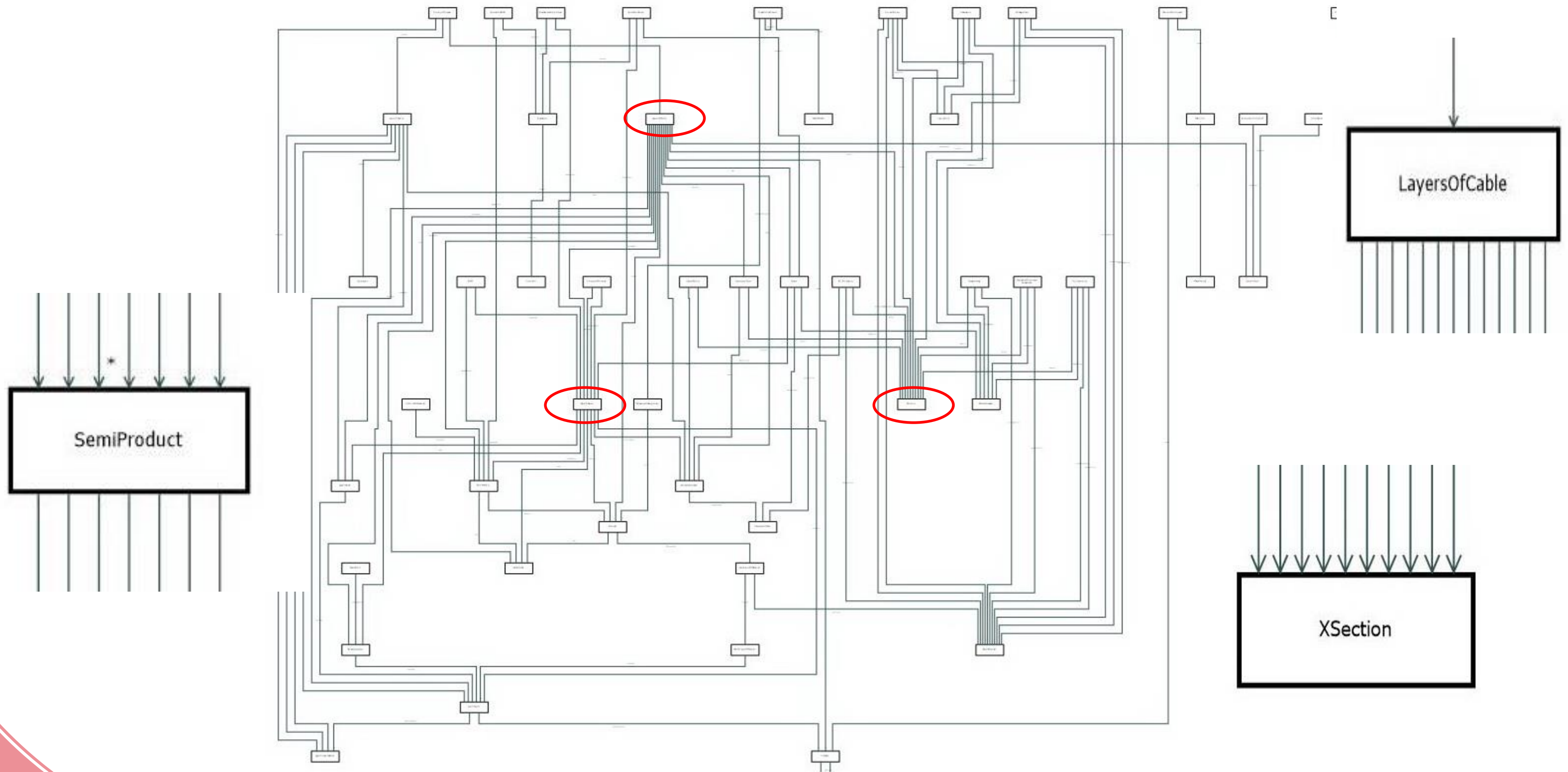


In process and Final QC



All new modules (or Classes) can be defined from beginning , which leads to fully **CUSTOMIZED system**

Blue Print of system / Diagram of Classes



Basic element of system / Table of Properties

Data_KB	Rows	Class	TableName
8	108	XSection	XSection
8	10	WrappingStyle	WrappingStyle
128	928	VoltageDrop	VoltageDrop
8	2	TypeTestRefrence	TypeTestRefrence
8	29	TestMethod	TestMethod
8	23	TapeWidth	TapeWidth
8	35	SubGroupOfMaterial	SubGroupOfMaterial
96	211	SemiProduct	SemiProduct
8	24	SectorRadius	SectorRadius
8	18	ReferenceStandards	ReferenceStandards
104	783	Reactance	Reactance
416	825	Raw Material	RawMaterial
8	19	RatedVoltage	RatedVoltage
8	15	QuotationSemiProduct	QuotationSemiProduct
8	2	QuotationDetail	QuotationDetail
8	5	QuotationBOM	QuotationBOM
8	1	Quotation	Quotation
216	3993	Property Of Layer	PropertyOfLayer
800	19586	ProductionFormula	ProductionFormula
40	131	Process	Process
8	31	Operators	Operators
64	105	Material	Material
8	5	MainGroupOfMaterial	MainGroupOfMaterial
8	91	Machines	Machines
8	27	MachineJob	MachineJob
32	317	MachineForProcess	MachineForProcess
8	2	ListPriceOfMaterial	ListPriceOfMaterial
8	3	LayingForm	LayingForm
8	9	LayerTypes	LayerTypes

User friendly interface to arrange the database **tables / fields / Classes**

Re-arranged Classes to facilitate the integration and programming

	LayersOfCable	1004913500000010150
	Cable	1004913500000010154
	PropertyOfLayer	1004913500000010158
	SemiProduct	7117913500000040110
	ProductionFormula	7117913500000060108

		DesignFormula
	LayerTypes	1004913500000010156
	LayerPropertyBase	1004913500000010157
	LayerProperty	1004913500000010159
	Operators	1004913500000010160
	LayerName	7117913500000000100

Capabilities of Model Driven Solution

- A Paperless Organization** ✓
Forms are designed for data entry and avoid parallel work and making papers
- Collecting and managing information** ✓
Provide powerful interface to collect and analysis information
- Workflow management** ✓
Define and Design the process of work flow
- Decision Making variables** ✓
Dashboards helps the management to make better decisions with more clarity
- Dynamic and Complete Solutions** ✓
Capabilities of develop to cover all organization process



Results of Model Driven Solution Implementation



Reduce

Time of Process

Well implementation of Process and quick decision making process

Reduce

Required personnel

Localize all data entry and calculations in related department

Remove

un-necessary process

Parallel and un-necessary form are being deleted or combined to proper process

Quick access to Information

Easy access to statistical reports and managers Dashboards