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ENTERPRISE WIDE COST MODELING: A SYSTEMS ENGINEERING PERSPECTIVE

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OUTLINE

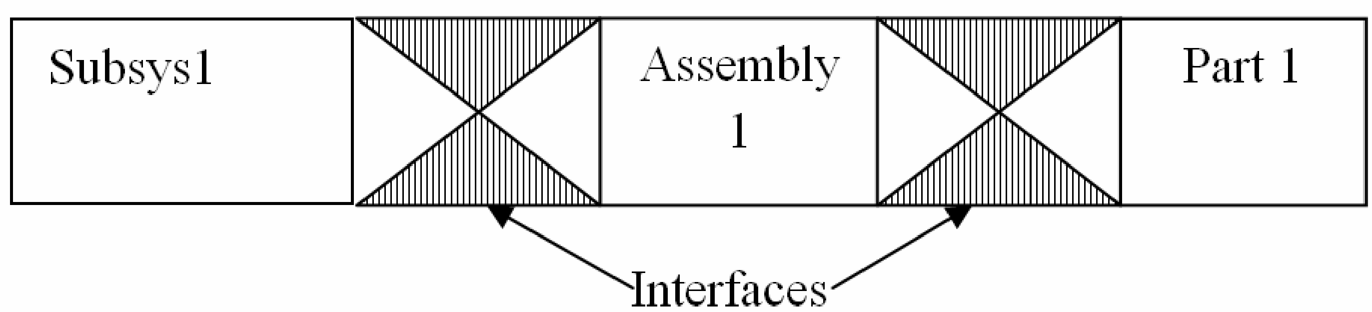
- Enterprise Wide Cost Modeling is approached from a systems engineering stand point.
- Risk and uncertainty, maintainability, reliability and other '-ilities' are applied to the core cost.
- A hierarchy of units is setup: System-Product-Assembly-Object.
- The cost model caters to the needs of cost estimation at every stage of the life cycle and for every kind of product, big or small, simple or complex.

OUTLINE Continued

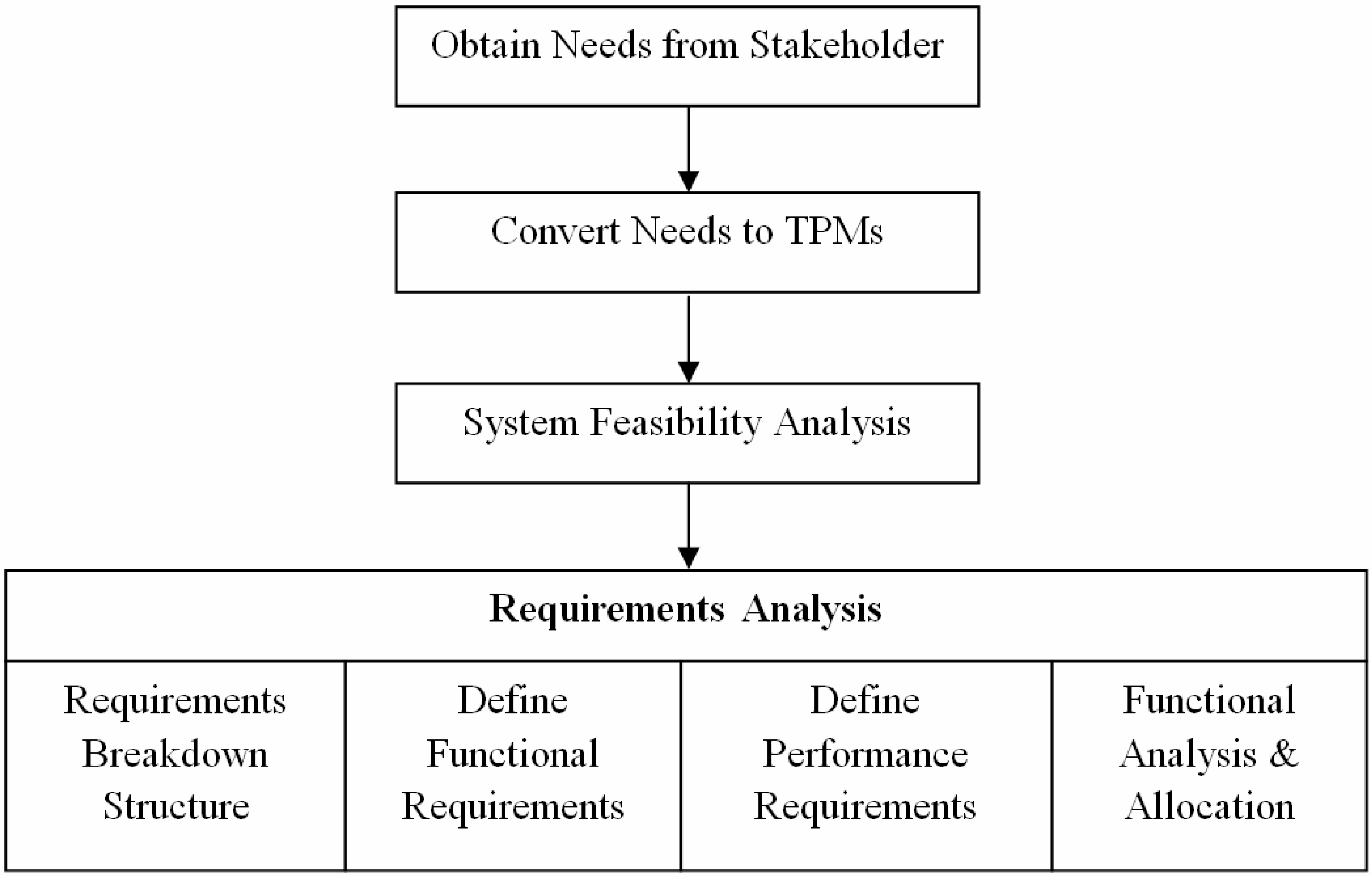
- New process selection tools have been added to the field of cost estimation which suggests the user with applicable processes given the material and production quantity.
- Attributes such as materials, fabrication processes etc… are ontology based. This is very useful since, in the preliminary stages of cost estimation, not much information is available.

SYSTEM HIERARCHY AND UNITS

- System
- Sub-system/Product
- Assembly
- Part/Object



SYSTEMS ENGINEERING PROCESS



METHODOLOGY

- The unit whose cost is to be estimated is the Target unit.
- A broad search is conducted to see which units are similar to the target unit. (Model Units)
- Among the model units, one candidate is chosen on the basis of its functional metrics being closest to that of the target's.

COMPARING FUNCTIONS

Target	Model 1	Model 2	Model 3	Model 4	Model i
F1	X	X	X	X	X
F2	X	X		X	
F3	X		X	X	X
F4		X	X		
.	X				
.					
.	X				
Fn					

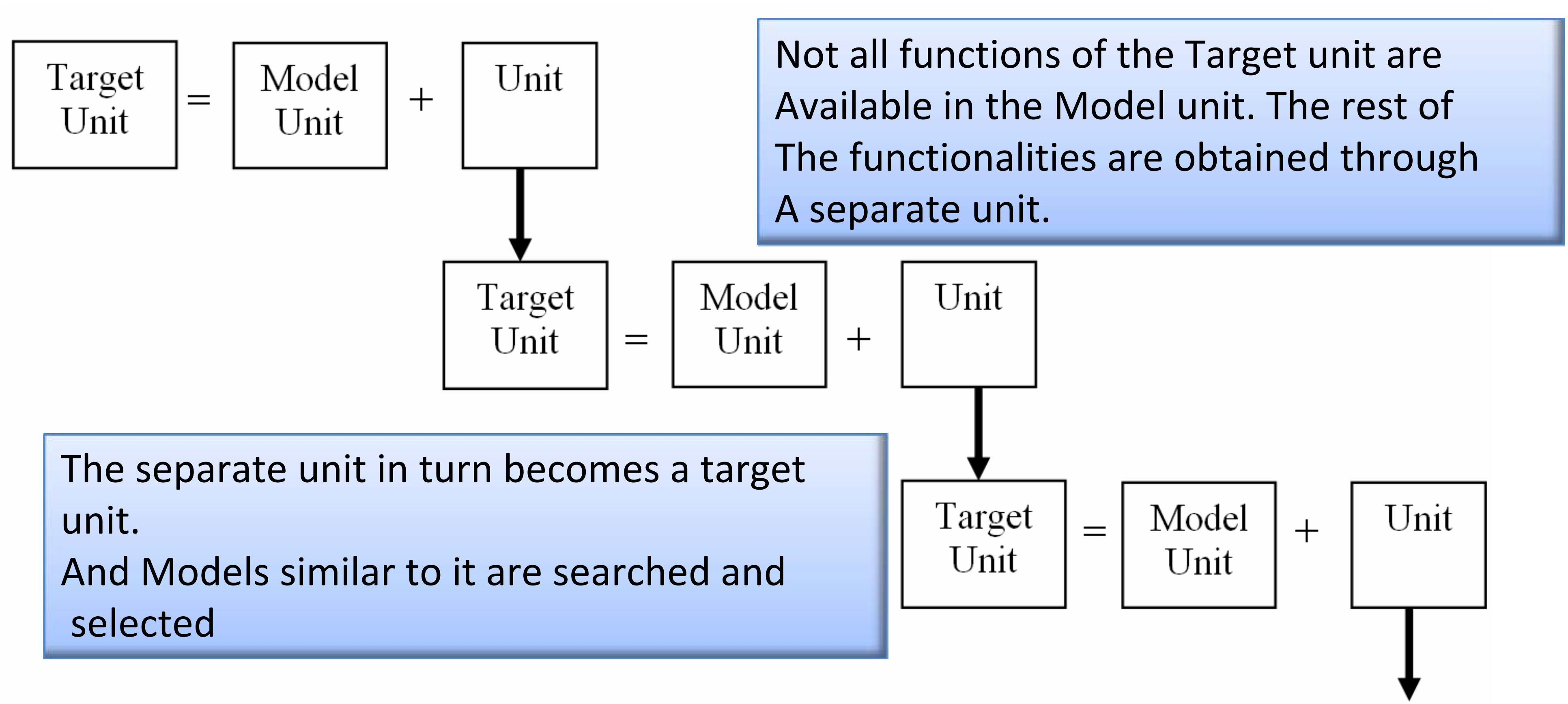
An X means that the functionality Fi of the Target unit is present in the Model unit

WEIGHTED RANKING OF MODELS

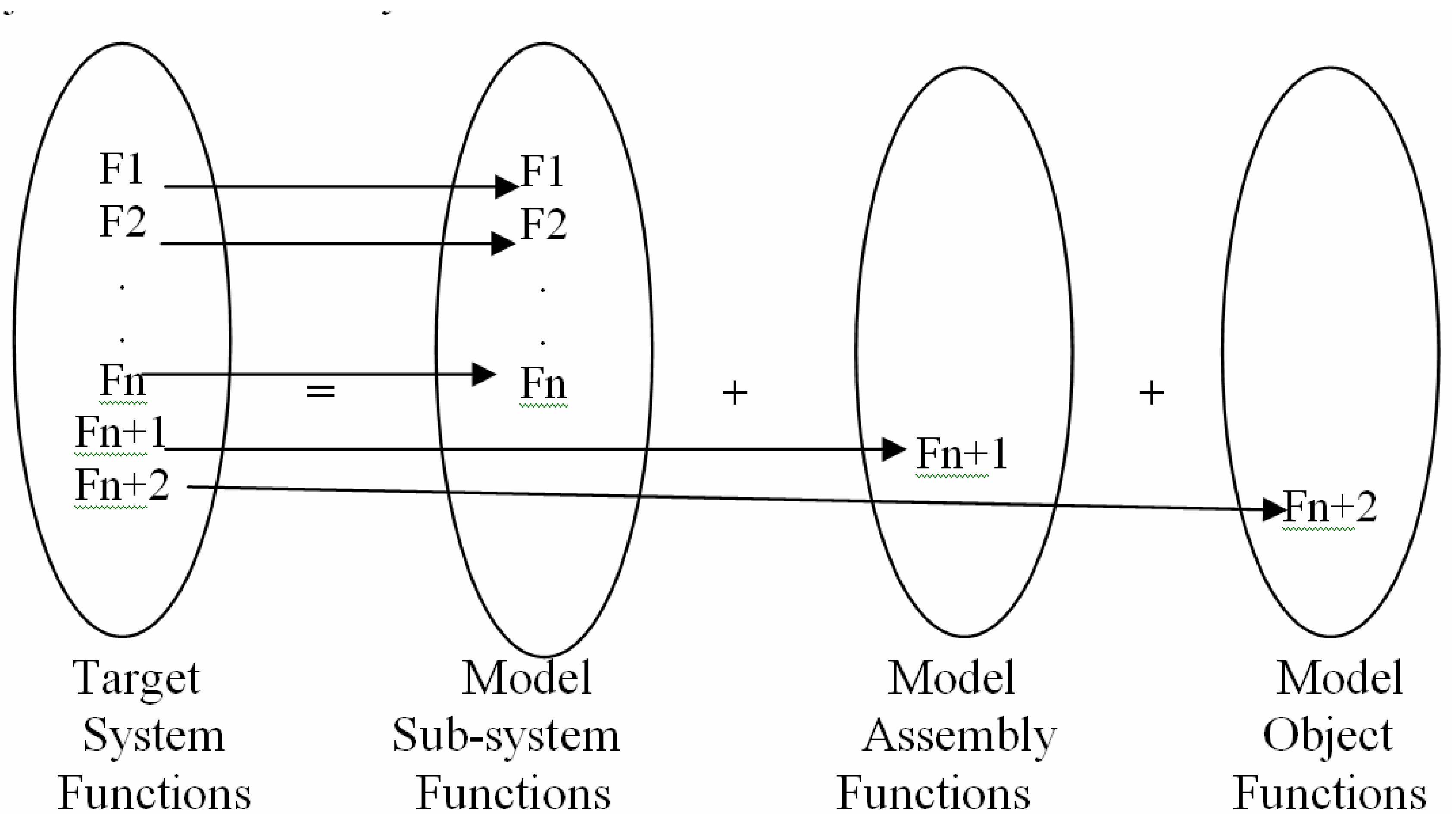
	Target	**Model1**	**Model2**	**Model3**	**Model4**	**Model i**
TPM Metrics Comparison	F1	2	3	5	3	1
	F2	3	8		7	
	F3	1		7	4	6
	F4		3	9		
	.	6		5	6	4
	.		4			
	.	6	5	3	4	6
	.		5		3	8
	Fn	8		4		2
	SUM→	26	28	33	27	27

The Model that has the highest weighted rank sum is the candidate model whose samples are to be collected.

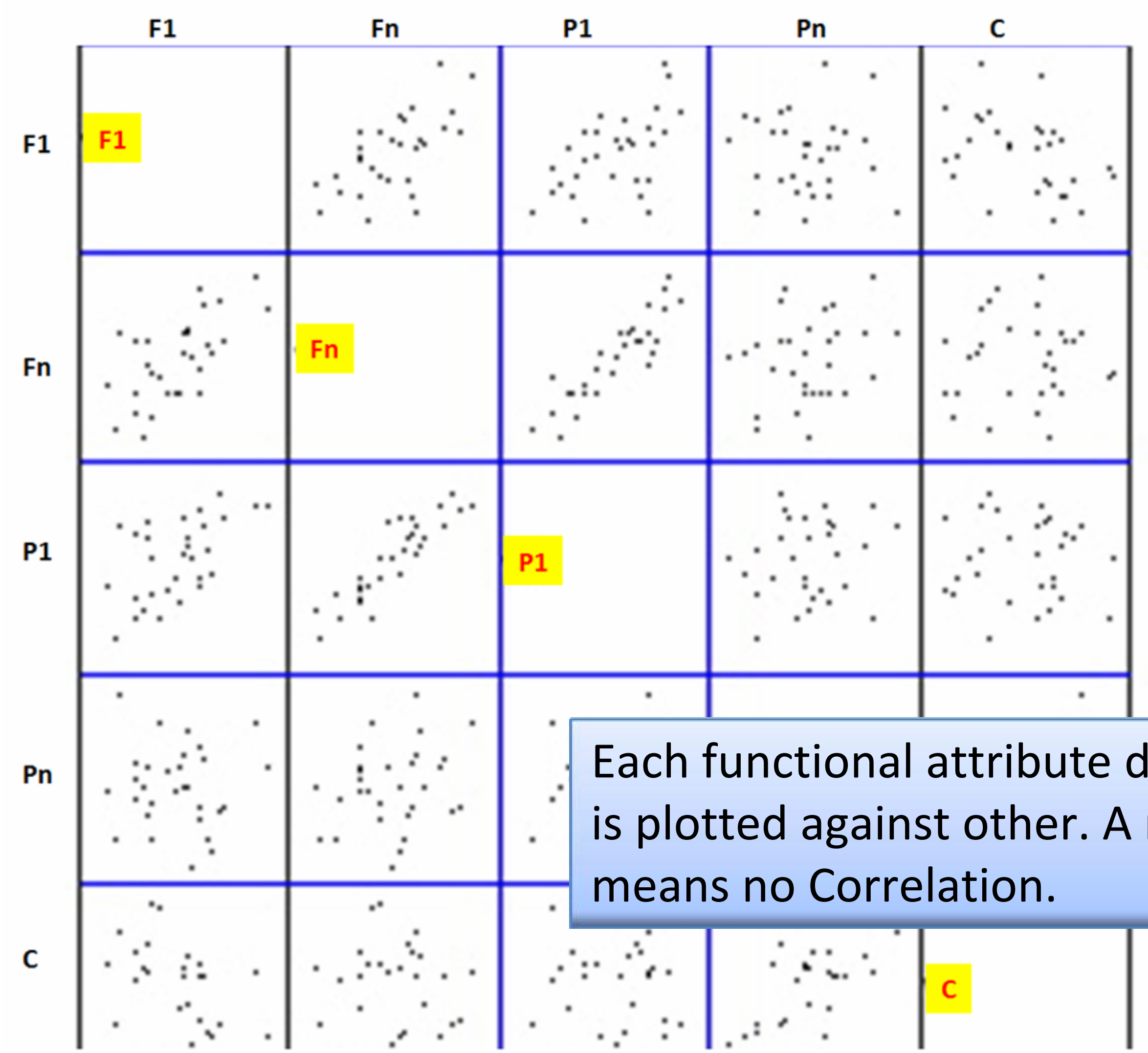
REPEATABILITY



TARGET SYSTEM FUNCTIONALITIES



CORRELATION



Each functional attribute data (of Model sample) is plotted against other. A random scatter means no Correlation.

SAMPLE MATH MODEL

Obtain the cost-coefficient matrix K and apply to target attributes to Obtain cost of the target unit.

$$\begin{Bmatrix} F^1_1 & F^1_{2\ldots} & P^1_1 & P^1_{2\ldots} & R^1_1 & R^1_{2\ldots} \\ \vdots & & & & & \\ F^Q_1 & F^Q_{2\ldots} & P^Q_1 & P^Q_{2\ldots} & R^Q_1 & R^Q_{2\ldots} \end{Bmatrix} \times \begin{Bmatrix} K1 \\ K2 \\ \vdots \\ Kn \end{Bmatrix} = \begin{Bmatrix} C^1 \\ C^2 \\ \vdots \\ C^Q \end{Bmatrix}$$

$F^1_1 \ldots F^Q_1$ Metric of Function-1 for the samples 1 to Q

$P_1, P_{2\ldots}$ Physical Attributes of Sample

$R_1, R_{2\ldots}$ Metrics of Reliability & Maintainability of the samples

C1, C2.. Cost of samples

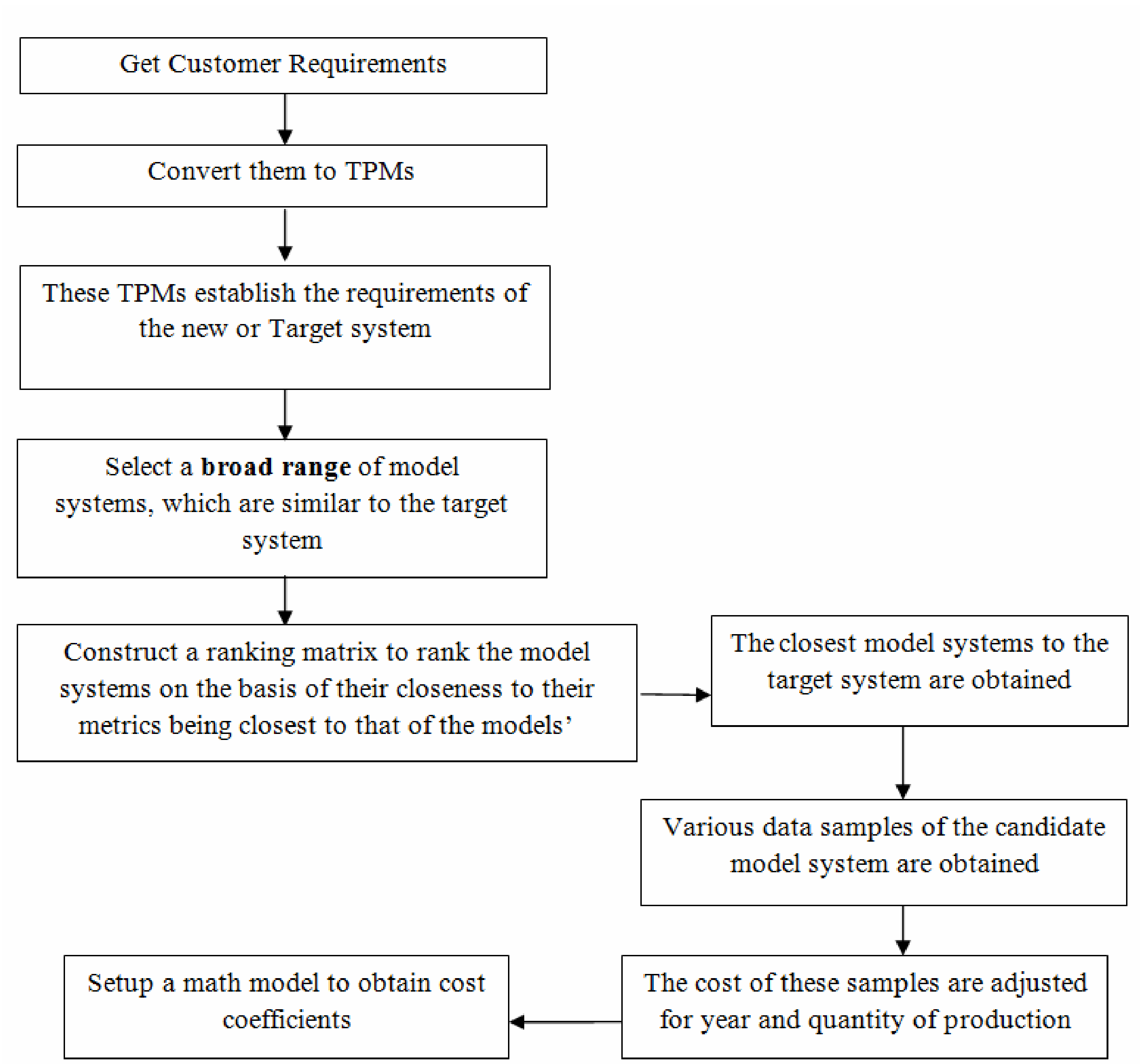
Cost of Target = $K_1F^T_1 + K_2F^T_2 + \ldots K_iP^T_1 + K_jP^T_2 + \ldots K_gR^T_1 +$

$F^T_1, F^T_{2\ldots}$ Functional Metrics of Target

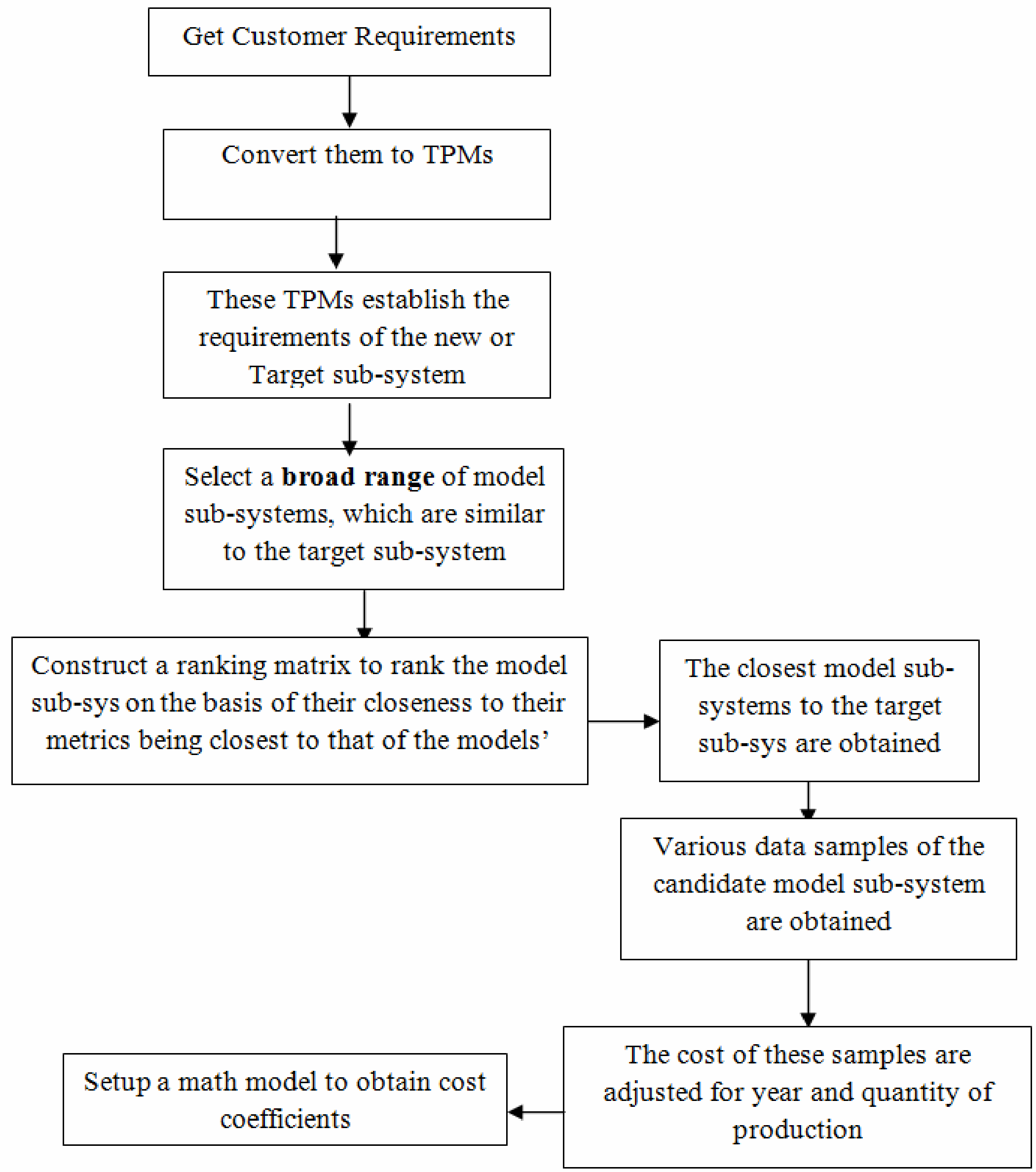
$P^T_{1}, P^T_{2\ldots}$ Physical Attributes of Target

$R^T_1\ R^T_{2\ldots}$ Metrics of Reliability & Maintainability of Target

SYSTEM-LEVEL METHODOLOGY



SUBSYSTEM-LEVEL METHODOLOGY



SUBSYSTEM LEVEL EXAMPLE

As an example a cost model of a Rotary Air compressor is developed here. The data is collected from *MSC 2002/2003 Industrial Supply Co. catalogue*

	Rotary Air Compressor		
	CFM	HP	PRICE($)
1	27	7.5	5015
2	35	10	6545
3	53	15	6824
4	79	20	7912
5	97	25	8361
6	112	30	9256

Model Samples for Rotary Air Compressor

The first five records were used to come up with a cost model and it was used to predict the cost of the sixth item. The cost model setup was a simple MLR.

SUBSYSTEM LEVEL EXAMPLE

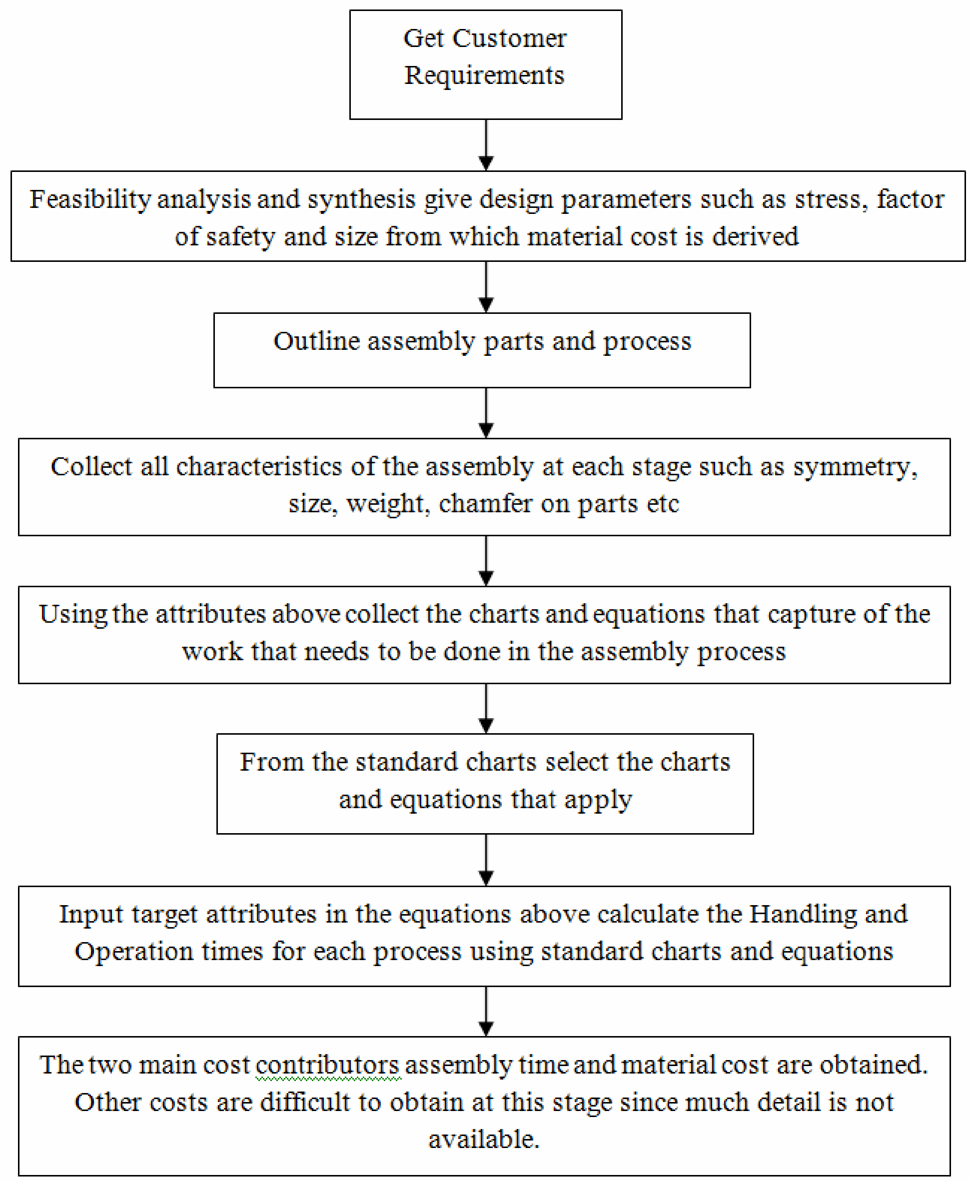
R Square	0.90
Adjusted R Square	0.80
Coefficients	
Intercept	4,055.37
CFM	-35.07
HP	317.22

Results from MLR

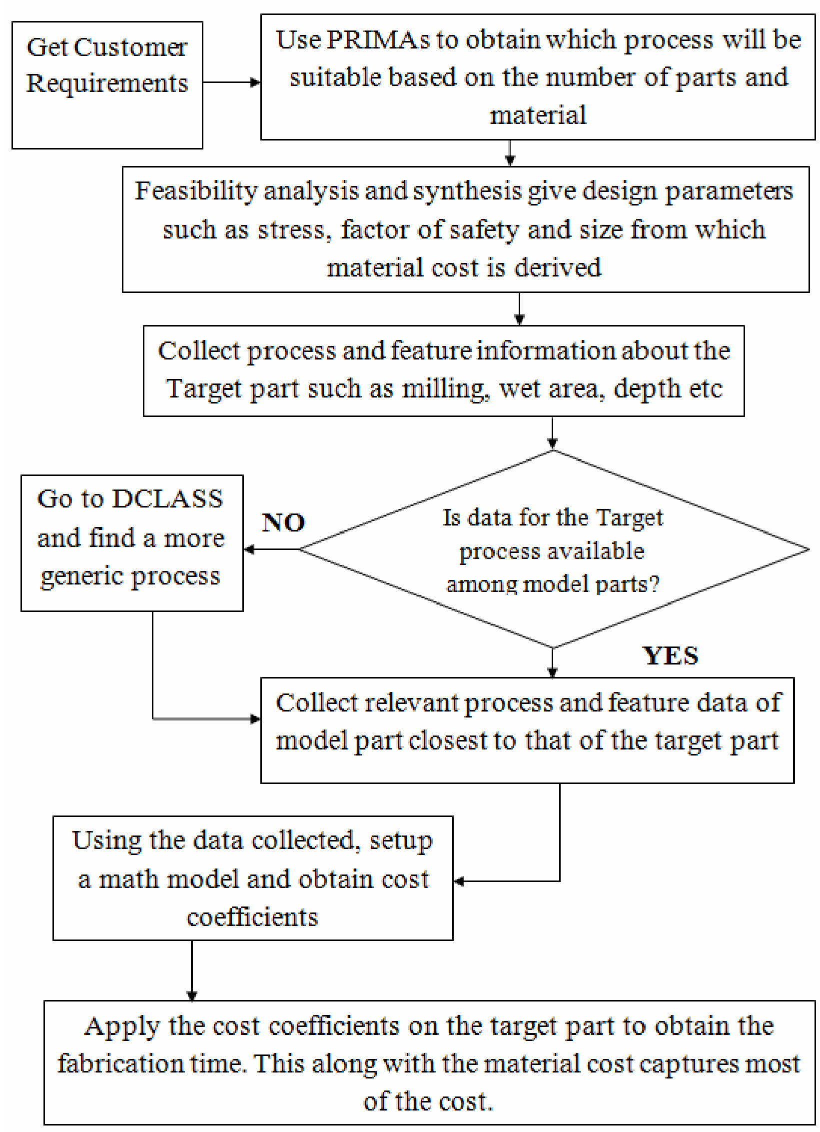
Cost = 4055.37 + (-35.07)*(CFM) + 317.22*(HP)

When this model is applied to the sixth sample of the data (CFM of 112 and HP of 30) the cost comes to $9,645 which is 5% off from the actual cost of $9,256.

ASSEMBLY-LEVEL METHODOLOGY

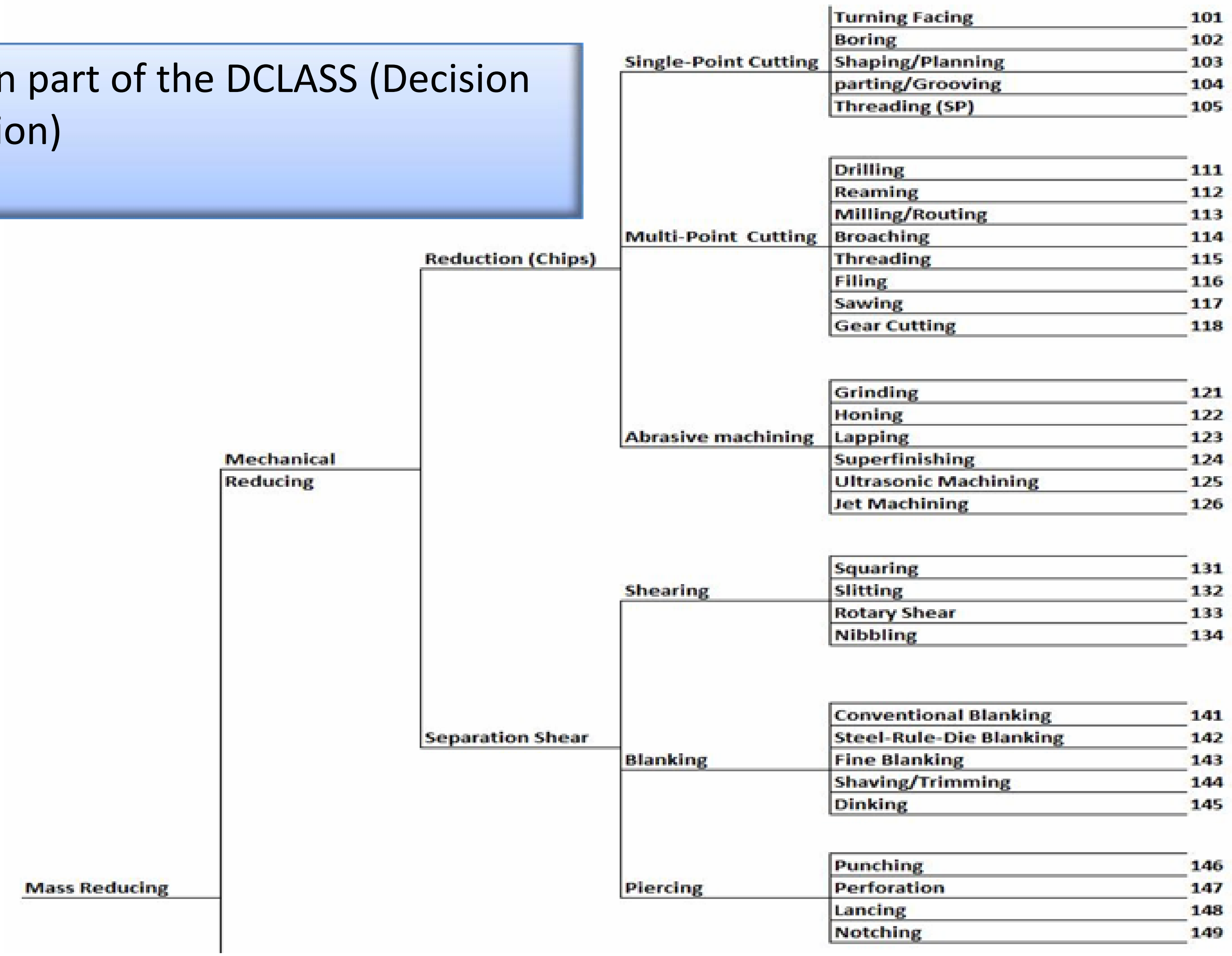


PART-LEVEL METHODOLOGY



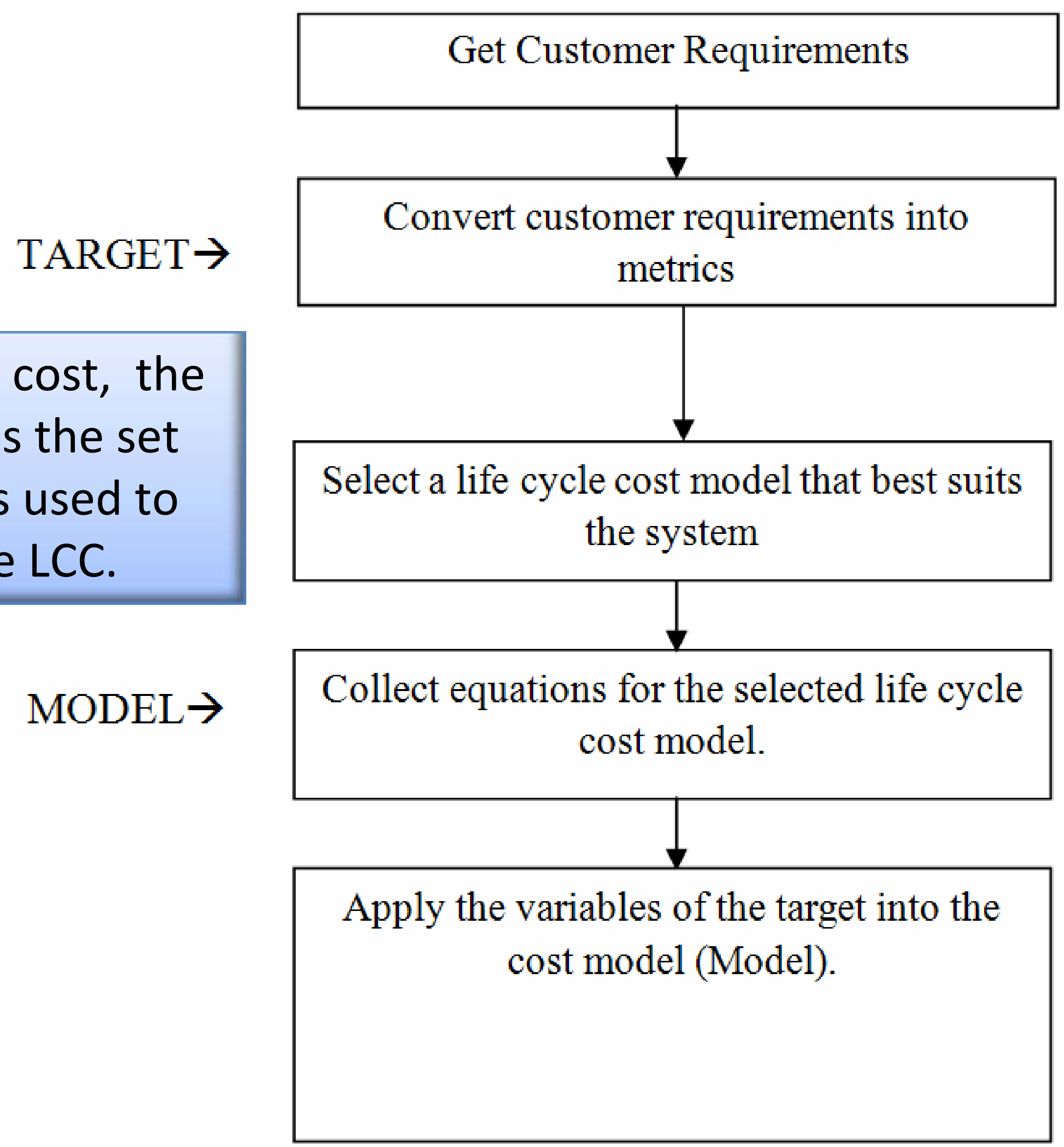
DCLASS

Fabrication part of the DCLASS (Decision Classification)



LIFE-CYCLE COST

In Life-Cycle cost, the Model unit is the set of equations used to calculate the LCC.



FUTURE WORK

- Make the framework more robust.
- Develop Sub-system level ontology similar to DCLASS.
- Simulate building of the system in a virtual environment.
- Database methodology to link data at each hierarchical level.
- A software that can build, interpret and estimate cost of a system.