

**R &D Creative Innovation**

# **Design For Six Sigma and TRIZ**

**Speaker : Jongnak Park**



**HYUNDAI**

NEW THINKING.  
NEW POSSIBILITIES.

Hyundai Motor's Tau 5.0 GDI engine was named one of the top 10 engines of 2011, making the list for the third consecutive year

**Tau V8 Engine, Ward's Auto  
"10 Best Engines of 2011"**

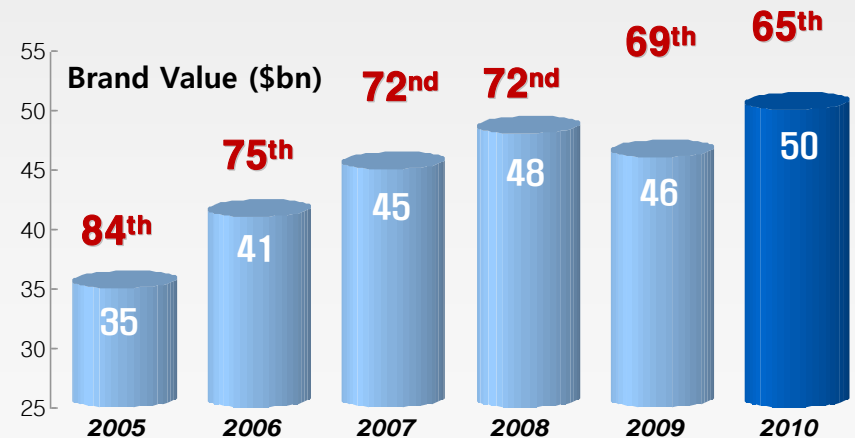


**HYUNDAI Achieves Top Brand Value  
Growth**

- No. 65 in the Best Global Brands 2010
- Brand Value : \$ 50 billion, 9.3 % growth rate (industry's average growth rate 2.8%)

## Hyundai's Brand Value Growth

(Rank No.8 in Auto industry)



## Winner of Vehicle satisfaction in Consumer Report, ALG, USA Today etc

※ Winner of AutoPacific 2010 Vehicle Satisfaction Award



“Genesis”

(Aspirational Luxury Car Award)

“Tucson”

(Compact SUV Award)



※ SONATA, Top Scorer ( USA TODAY, Family Sedan)



※ Consumer Report



※ Benga, Winner of Redot Design Award (3/15)






reddot design award  
winner 2010



※ K5/Spotage R, Winner of iF Design Award (12/6)



## ■ NCAP(New Car Assessment Program) Test Results

차종	Frontal impact	Offset Impact	Side impact	Rear impact	Total pts
<b>K7 (KIA)</b> 	★★★★★ (95%)	★★★★★ (97%)	★★★★★ (100%)	★★★★★ (83%)	<b>53.7pts (99%)</b>
<b>ES350 (Lexus)</b> 	★★★★★ (100%)	★★★★★ (91%)	★★★★★ (100%)	★★★ (50%)	<b>49.6pts (92%)</b>
<b>E220 CDI (Benz)</b> 	★★★★★ (76%)	★★★★★ (89%)	★★★★★ (100%)	★★★★★ (75%)	<b>49.0pts (91%)</b>
<b>A6 (Audi)</b> 	★★★★★ (81%)	★★★★★ (94%)	★★★★★ (96%)	★★★★★ (60%)	<b>47.0pts (87%)</b>

## 2010년 충돌안전성 종합평가 순위

순위	차종	종합점수
1	기아차 K7	53.7
2	현대차 쏘나타	53.6
3	현대차 아반떼	53.4
4	기아차 K5	53.3
5	기아차 스포티지	50.6
6	현대차 투싼	50.3
7	르노삼성 SM5	49.7
8	렉서스 ES350	49.6
9	GM대우 마티즈	49.2
10	벤츠 E220 CDI	49.0
11	아우디 A6	47.0
12	르노삼성 SM3	45.2

자료: 국토해양부





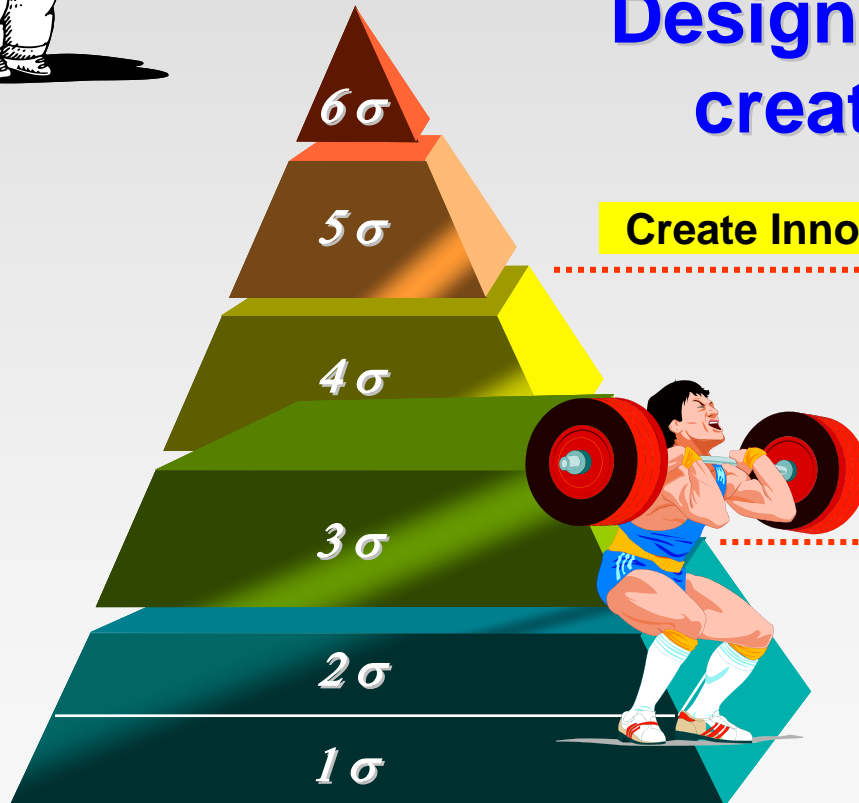
## Hyundai Motor : The toughest car company of them all



It installed **Six Sigma** at its Engineering Center to measure its improvement. It made quality a cross functional responsibility, with involvement from procurement, finance, and sales and marketing. It enlisted outside suppliers and put them together with designers and engineers to work out problems before they occurred.



## Design For Six Sigma creation process



Create Innovative Concept

Improve Robustness

### Six sigma (DMAIC)

DMAIC process often hits the 5sigma wall as the point of diminishing returns

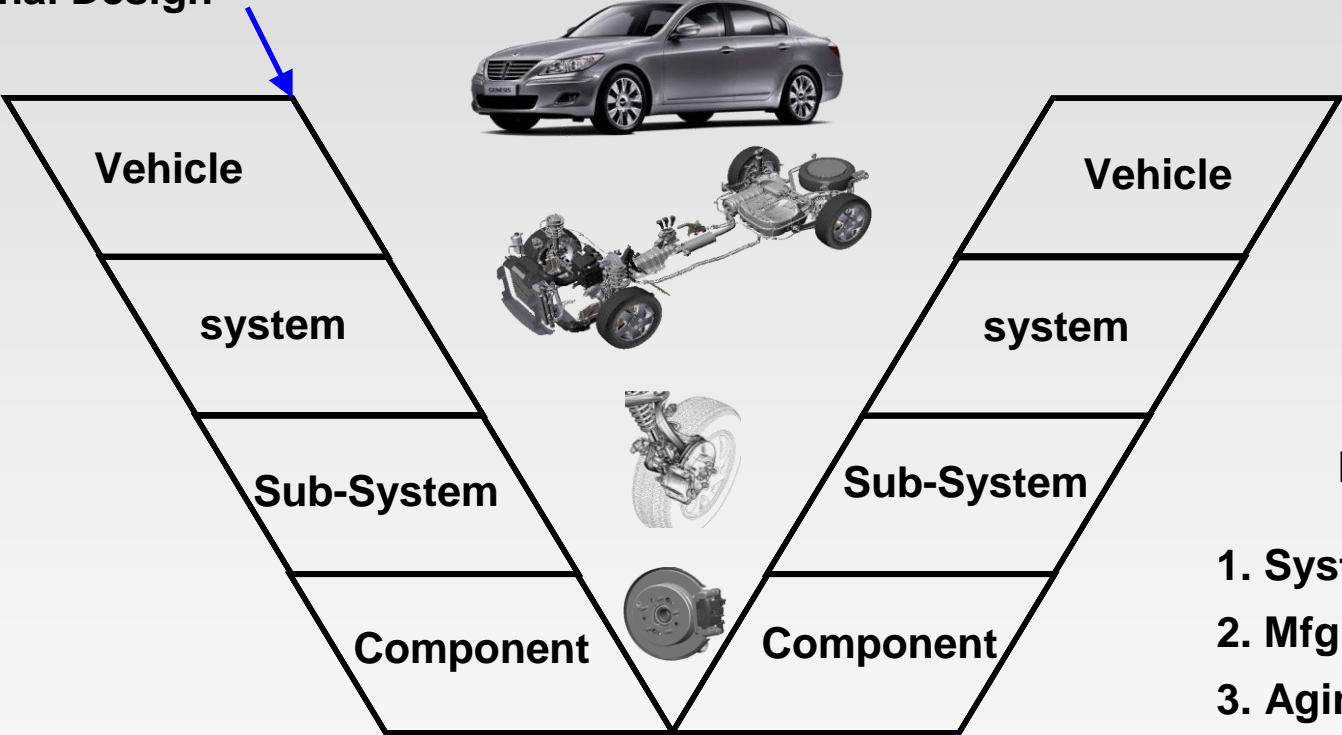
Engineering Experience  
QC 7 Tools

## Component Innovation



## Vehicle Innovation

Top Down  
Functional Design



Bottom up Integration  
& testing with Noises

Noise

- 1. System Interface
- 2. Mfg variation
- 3. Aging
- 4. Customer Usage
- 5. Environment

**DFSS is a way of Thinking to Create Design for user**

- **Ongoing Continuous and Breakthrough Improvement**
- **Enhance Organization Communications**
  - Top-Down Communications, Bottom-Up Communications
- **High-Powered Teams Building**
  - Foster Team Discipline, Growth
- **Establish Shared Purpose**
- **Create a Learning Organization**
- **Foster Intrinsic/Extrinsic Motivation**

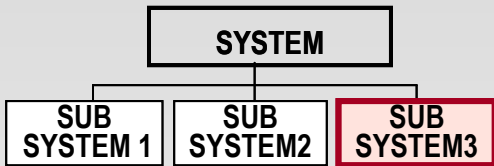


# Transactional DFSS Storyboard

(8/21)

## IDENTIFY PROJECT      DEFINE REQUIREMENTS      DEVELOP CONCEPT

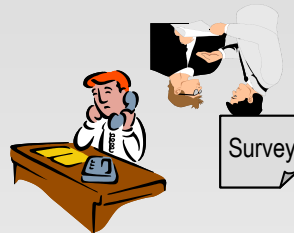
**1** Refine Charter & Scope



**2** Develop Project Plan

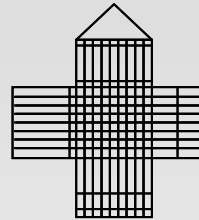
**3** Form Team

**4** Understand Customer Needs  
QFD PHASE 1:



*Voice of Customers*

**5** Build House of Quality  
QFD PHASE 1:



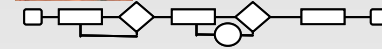
*Company Measures*

Concept Generation

- 6** Conduct MSA
- 7** Establish Baseline
- 8** Conduct TRIZ Concept Generation



*Creative Solution!!*



*Creativity Toolkit  
Mind map, Morphological analysis*

Concept Selection

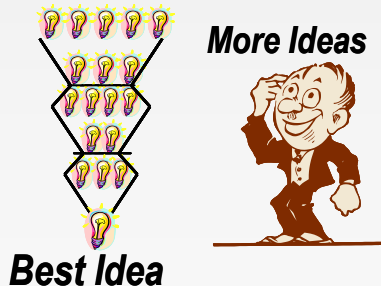
**9** Conduct First Run

	1	2	3	4	5
CRITERIA					

**10** Conduct Confirmation Run

## OPTIMIZE DESIGN

**11** Conduct Controlled Convergence to Strengthen Concept

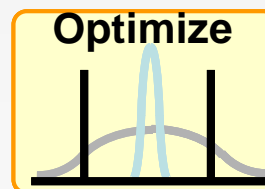


**12** Conduct FMEA



Failure Modes  
Occurrence  
Severity  
Detection  
Risk Priority Number

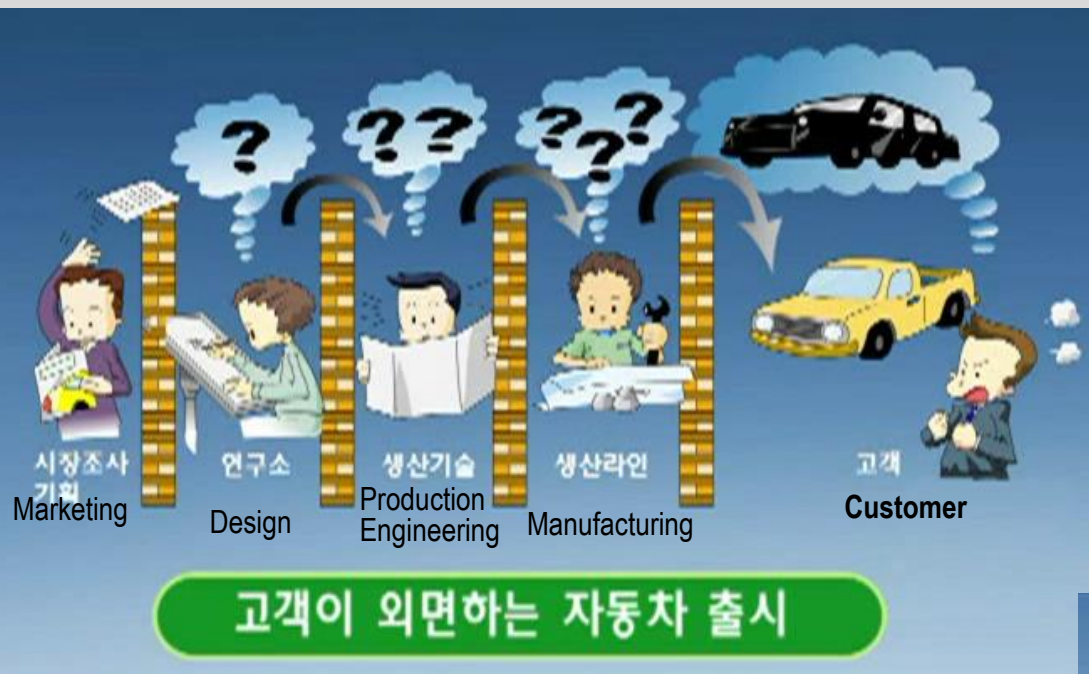
- 13** Develop QFD PHASE II: Process Planning Matrix
- 14** Optimize Design (Step 1)
- 15** Adjust to Target (Step 2)
- 16** Conduct Tolerance Design



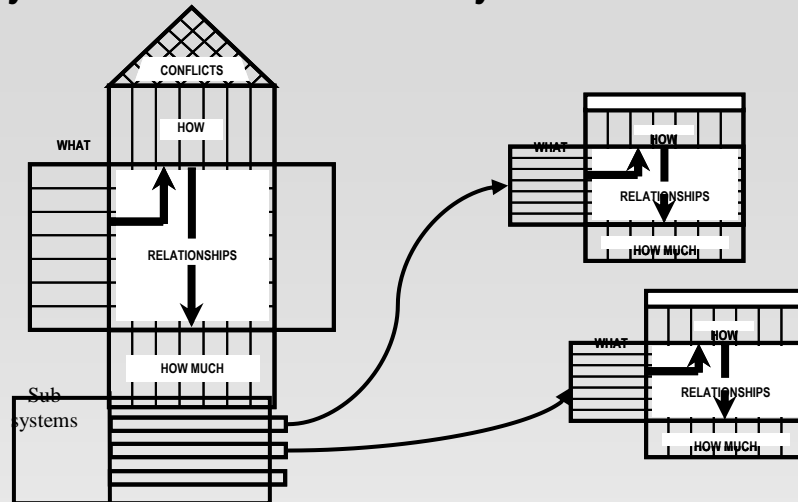
*Taguchi Methods*

## VERIFY & LAUNCH

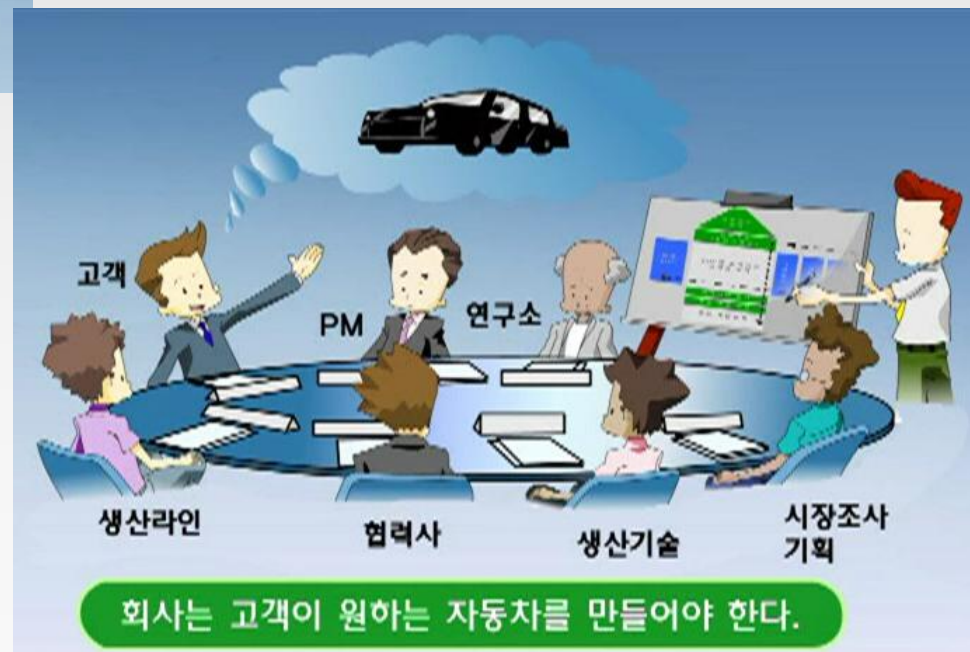
- 17** Develop QFD PHASE III: Operations Planning Matrix
- 18** Finalize Service Processes
- Conduct Trial Run
- 19** Conduct Pilot Run
- 20** Implement and Confirm Performance
- 21** Track and Improve Performance



## System Level House of Quality

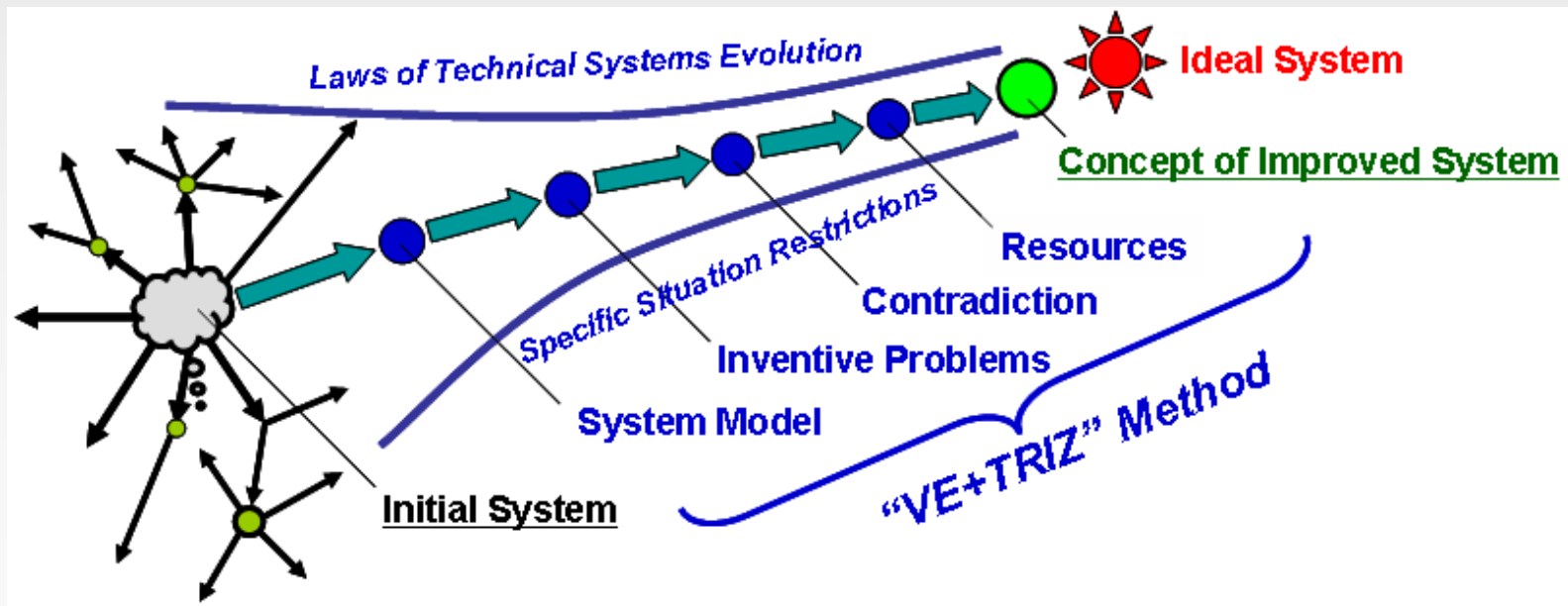
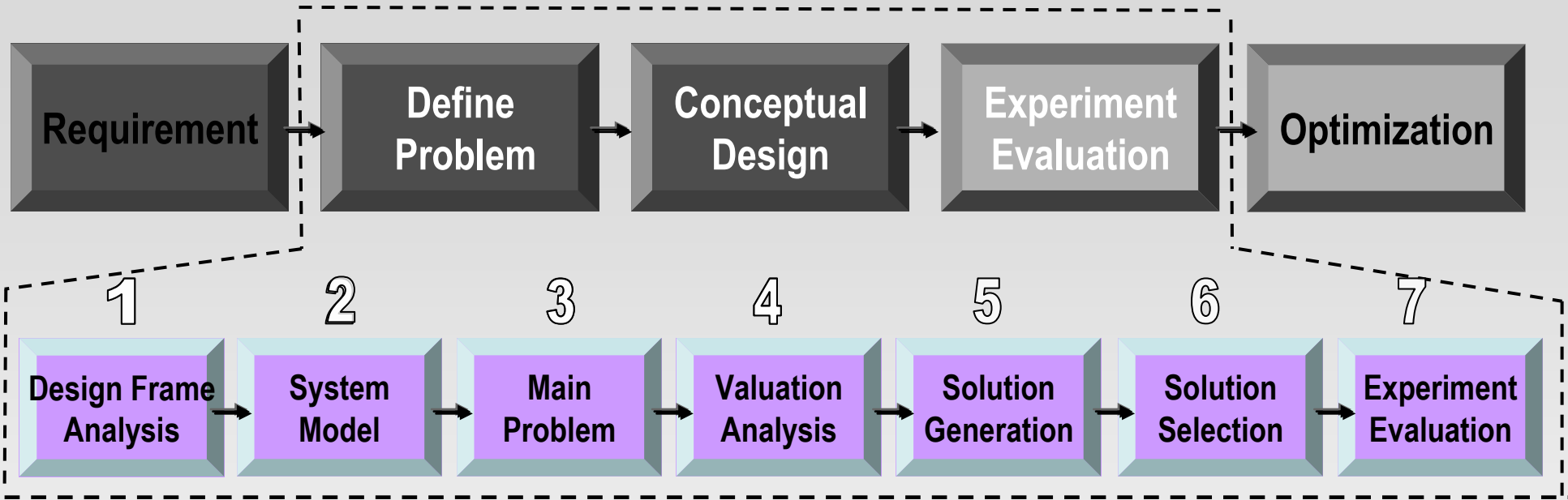


- ❑ Reduction Cycle time of Design 30 ~ 50%
- ❑ Reduction Cost of Development 20 ~ 60%
- ❑ Reduction Engineering Change Order 30 ~ 50%

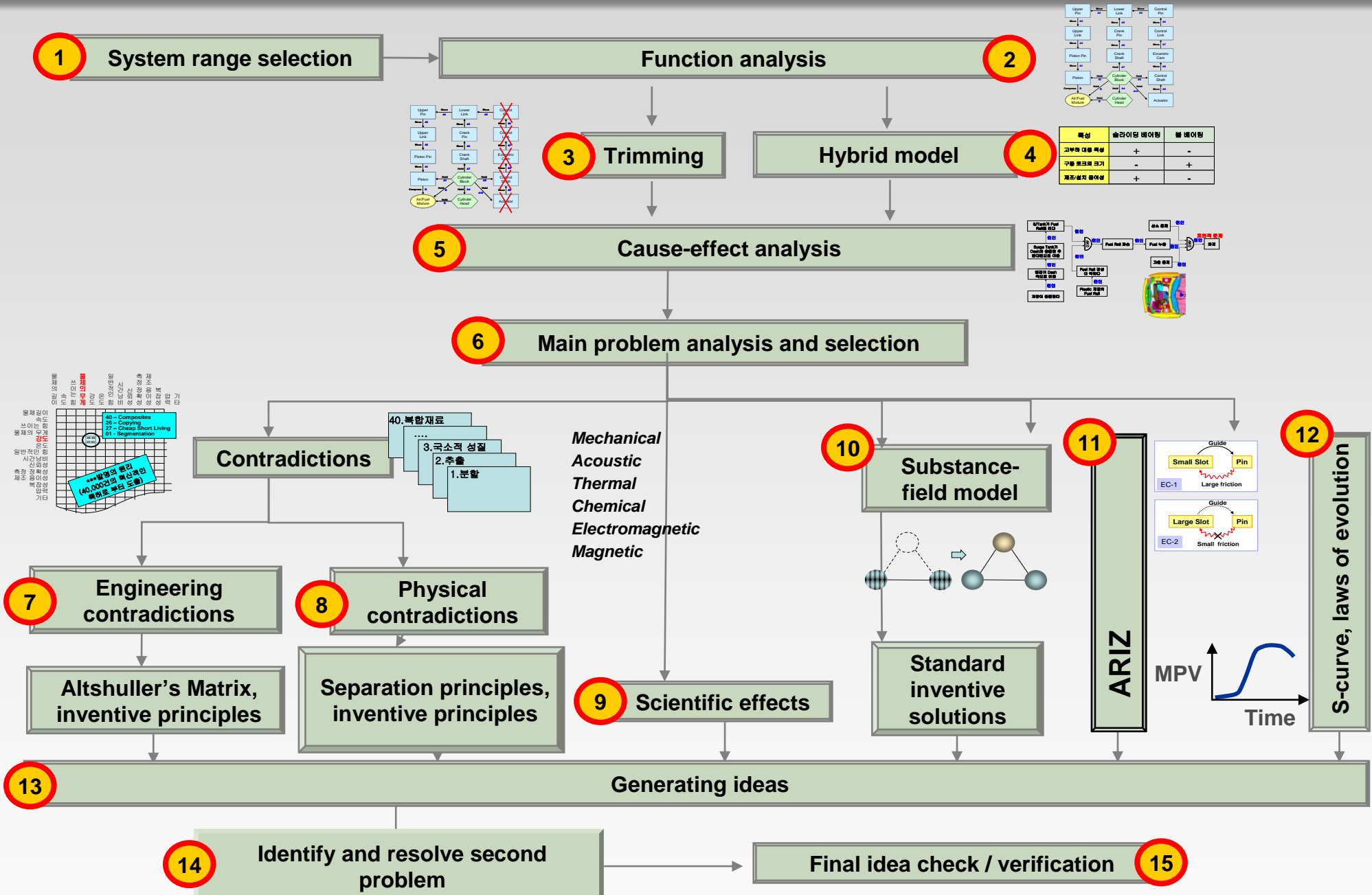


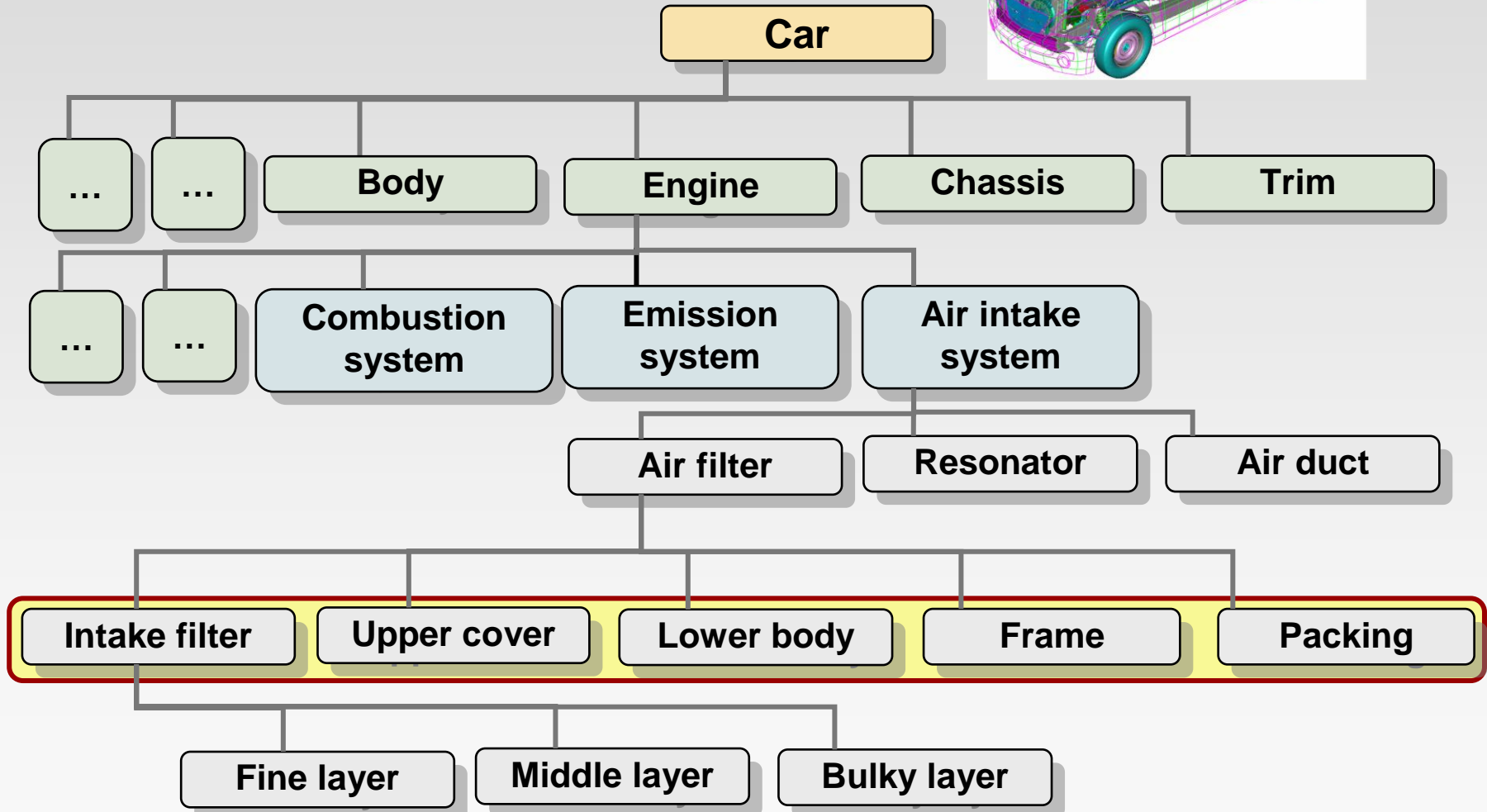
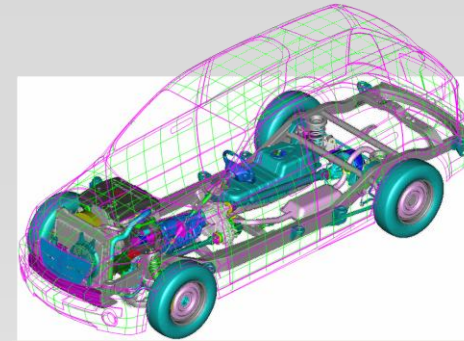
# Concept Generation - TRIZ

(10/21)



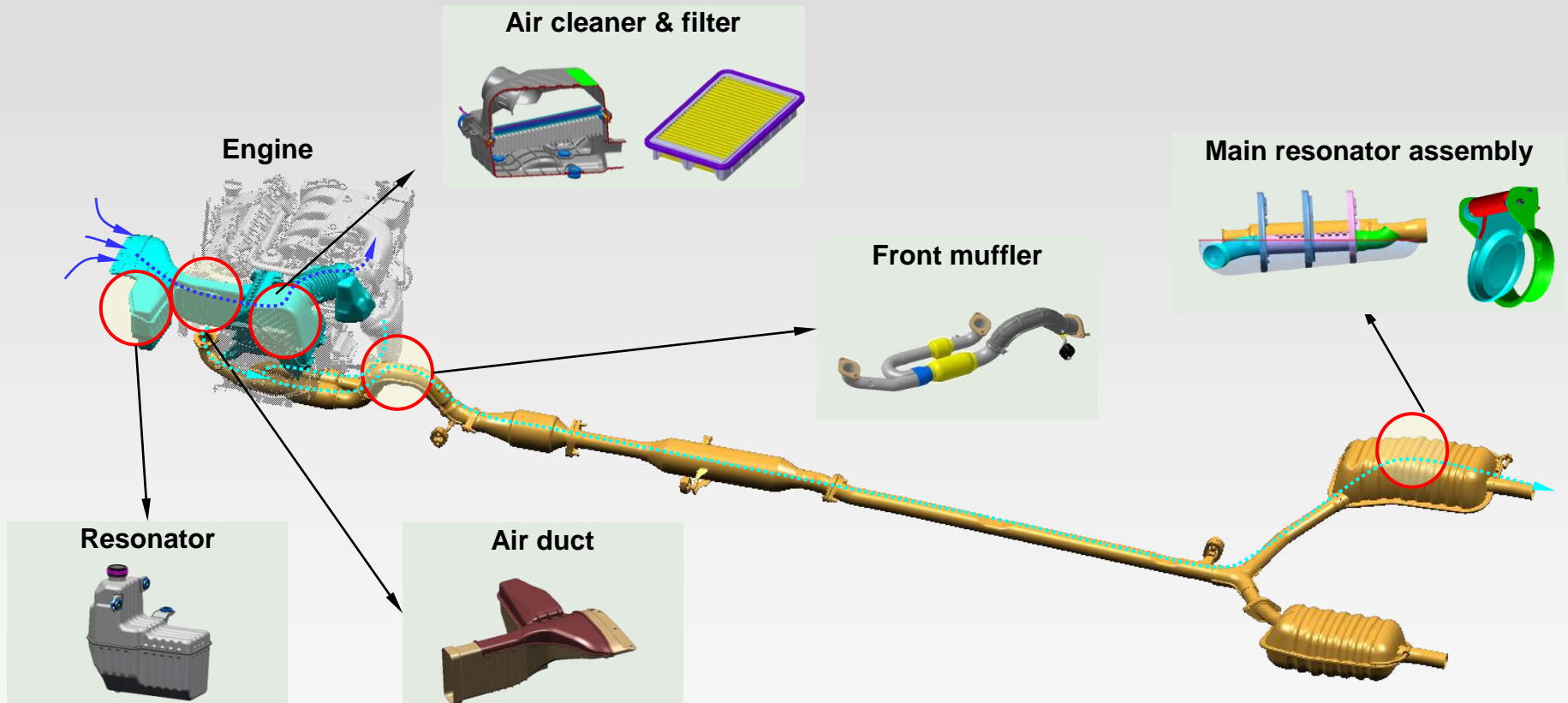
# Hyundai Motor's TRIZ Roadmap





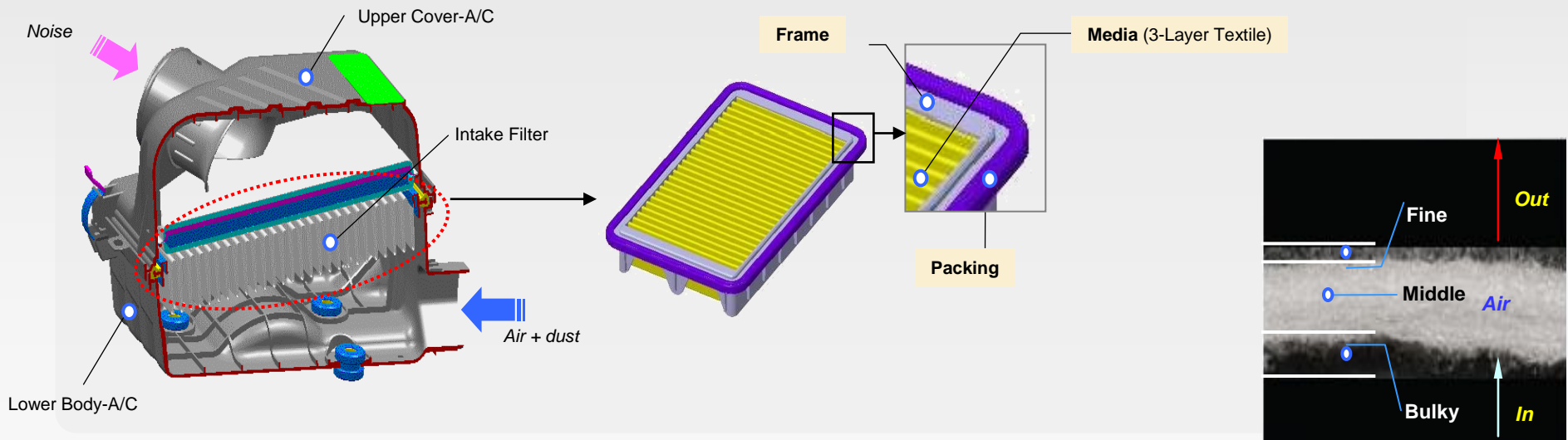


# Intake and Emission System

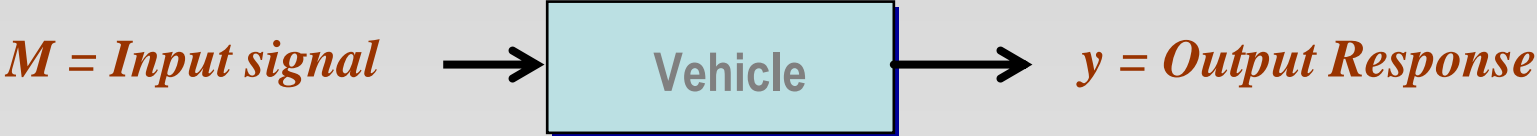


## Example: Air Cleaner Filters

- ❖ To maintain smooth air flow for optimal engine performance, the filter must be changed often. However, to lower filter replacement cost, the filter must be larger and the product price goes up. If the filter is small, it must be replaced more often.
- ❖ Goal: Improve the filter's performance to maintain the engine's performance without frequent filter replacement .



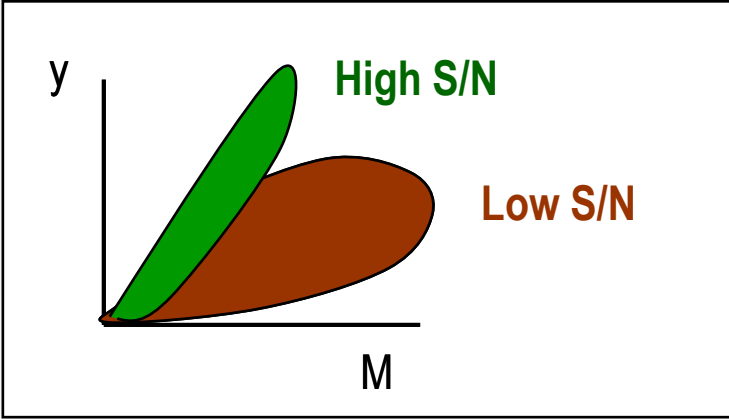
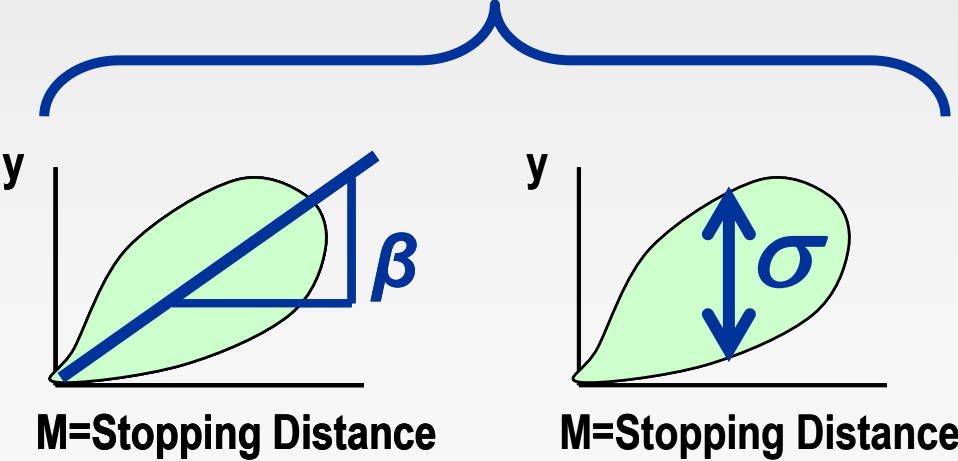
# Taguchi Robust Engineering - Optimization



Signal to Noise Ratio is a metric for “Robustness”

You want high  $\beta$  and small  $\sigma$ .

$$S / N = 10 \log \frac{\beta^2}{\sigma^2} \rightarrow \frac{\text{Efficiency}}{\text{Variability}} \rightarrow \frac{\text{Intended Work}}{\text{Variability of Work}}$$

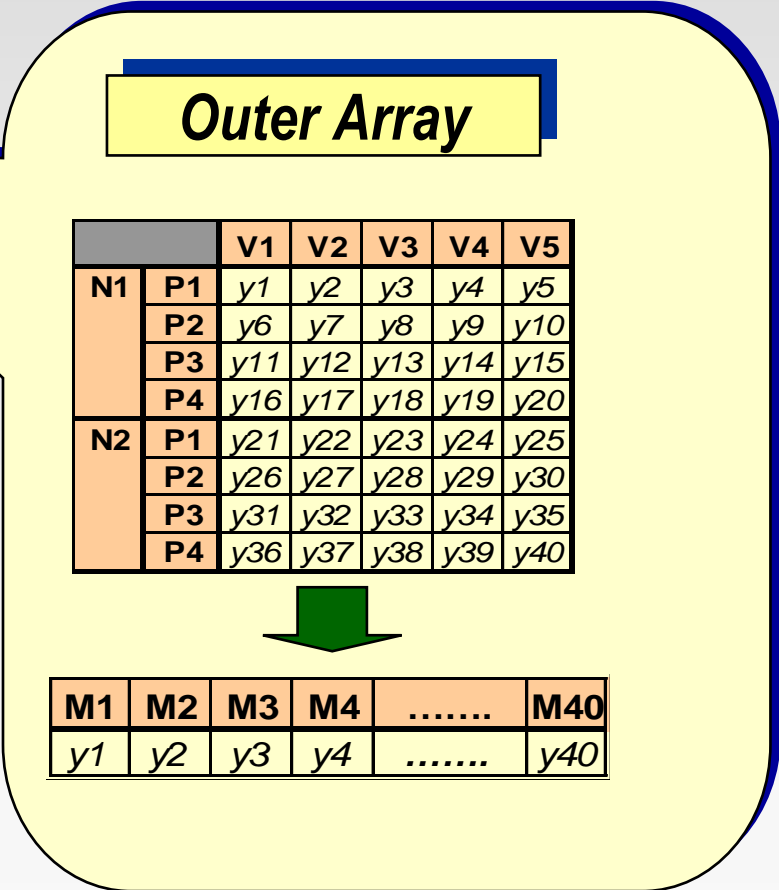


# Inner Array and Outer Array

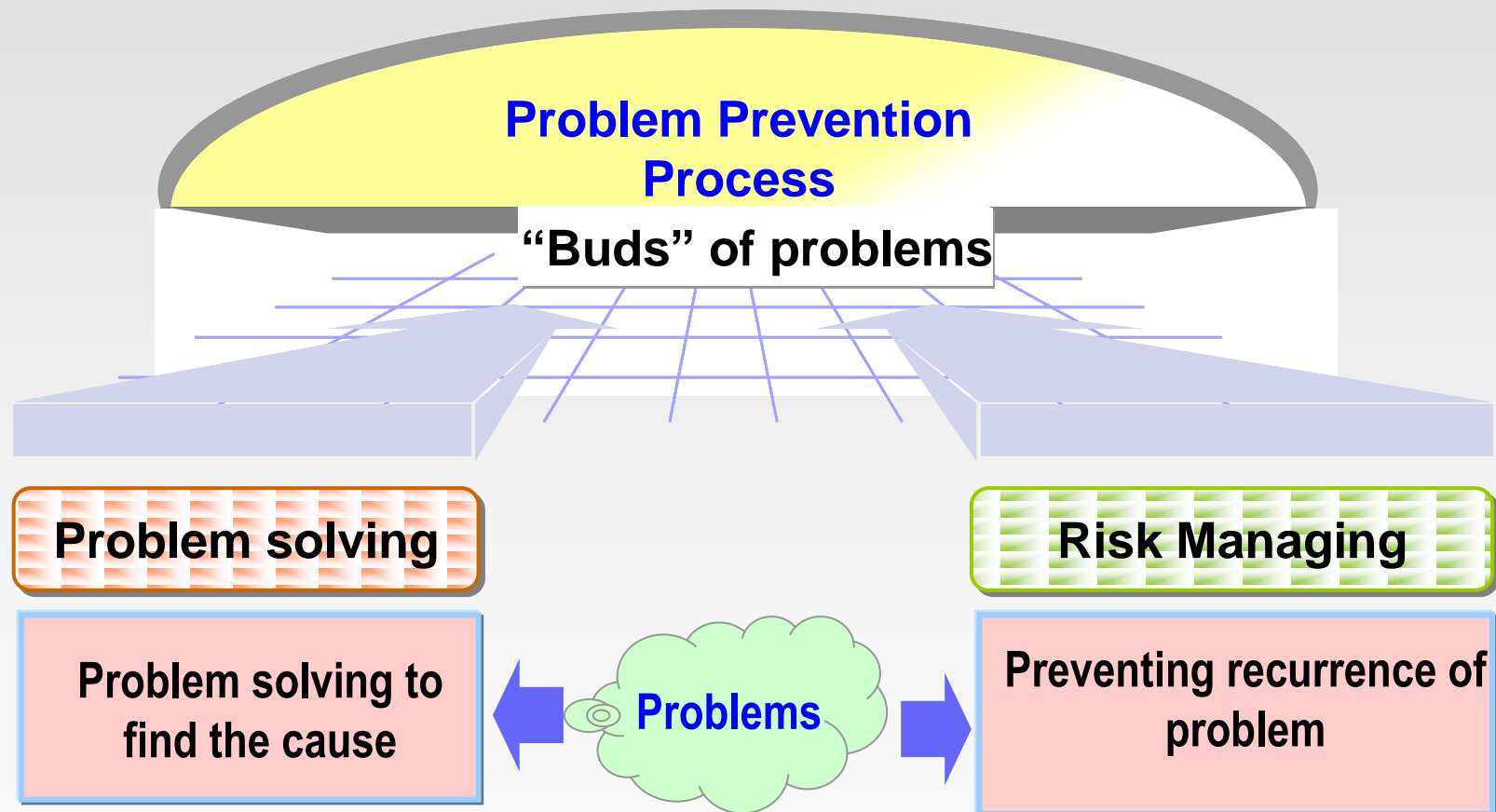
**Control Factors** } Assigned to an inner array!  
**Signal Factors** }  
**Noise Factor** } Assigned to an outer array!

	A	B	C	D	E	e	e	e	Outer Array
	1	2	3	4	5	6	7	8	
1	1	1	1	1	1	1	1	1	
2	1	1	2	2	2	2	2	2	
3	1	1	3	3	3	3	3	3	
4	1	2	1	1	2	2	3	3	
5	1	2	2	2	3	3	1	1	
6	1	2						2	
7	1	3						3	
8	1	3						1	
9	1	3						2	
10	2	1						1	
11	2	1	2	1	1	3	3	2	
12	2	1	3	2	2	1	1	3	
13	2	2	1	2	3	1	3	2	
14	2	2	2	3	1	2	1	3	
15	2	2	3	1	2	3	2	1	
16	2	3	1	3	2	3	1	2	
17	2	3	2	1	3	1	2	3	
18	2	3	3	2	1	2	3	1	

**Inner Array**



- The objectives of the verify phase are to assure that:
  - the customer receives all the benefit possible from the product by seeking out **“Buds” of Problems**
  - the product performs to the key targets
- **Creative FMEA** is the backbone to verifying the predicted improvements





**1 Complete DFSS & TRIZ 3,000 Themes**

**2 Financial Effect ₩ 3 trillion**

**3 Securing 1,500 Patent**

**4 DFSS Experts (Champion, MBB, BB, GB): 70%**  
**TRIZ 3-Level : 59 engineer, 2-Level : 15 engineer**

- 2011. 11. 10 7<sup>th</sup> DFSS Day



- Winner Themes Selection



- VOC Workshop



- DFSS training



The Toughest challenge business leaders face is how to achieve and sustain competitive leadership. Those that improve the fastest win. Winning offerings delight customers with stunning quality, reliability, And competitive prices.

TRIZ is creative weapon for Winner



**Thank you**