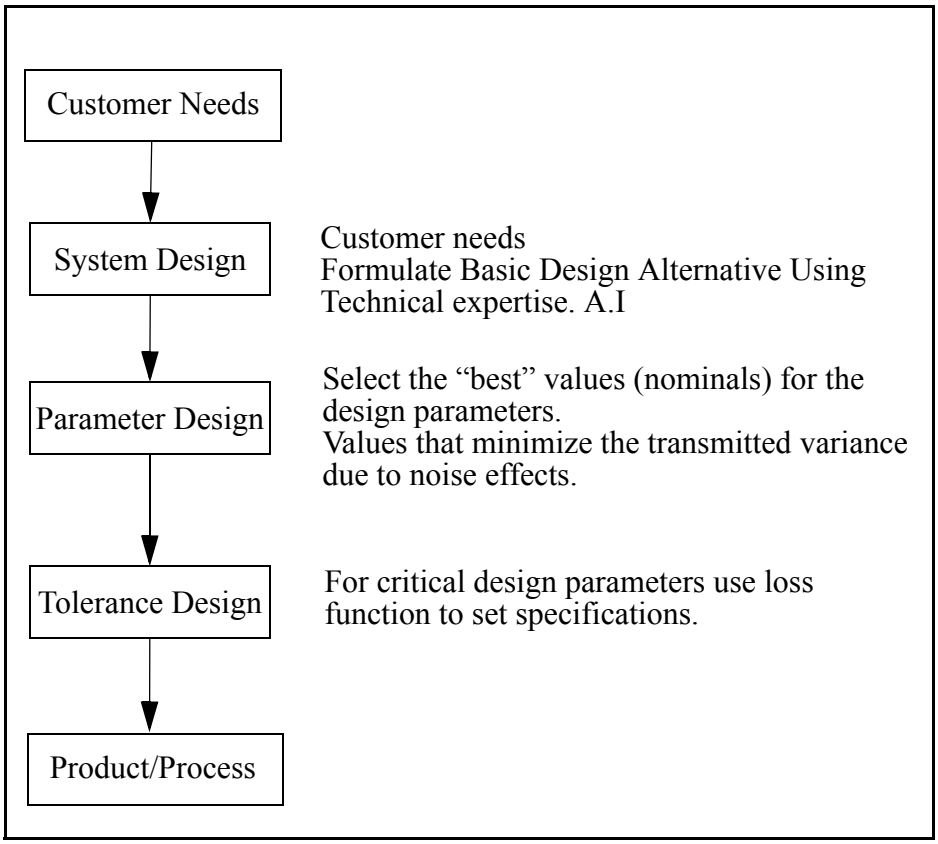
9.0 TAGUCHI'S CONTRIBUTIONS

(Updated Spring 2001)

- Model of the Engineering Design Process
- Decomposition of the factors that influence product/process performance
- Emphasis on variation reduction-use of the loss function and signal-to-noise ratio
- Robust design idea
- The use of orthogonal arrays to perform experiments.

As we examine these, we will note if there are any problems.

Model of Engineering Design Process



Consider the following example:

Roles of factors in Influencing Product /Process Performance

Study fuel economy:

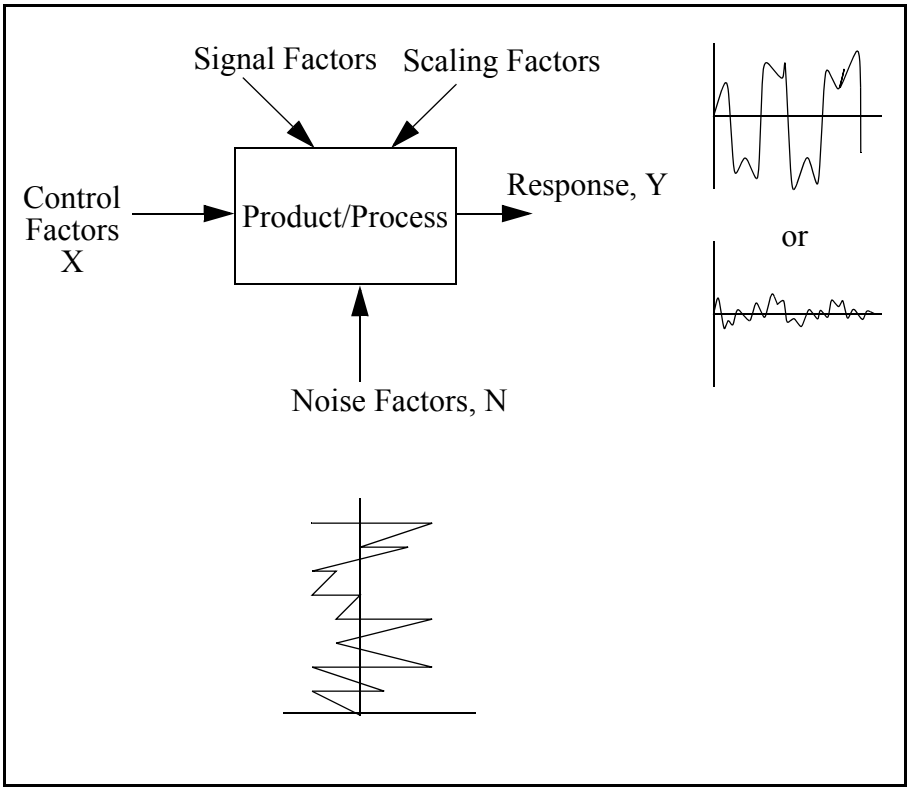
Carb. Design	A	B
Eng. Disp.(liters)	2.8	3.4
Tire Press (psi)	22	28
Driving Speed (m.p.h.)	45	55

We are not looking for the best combination of variables that optimize or economize, rather we want a combination of all that provide target mean and small variability.

Using traditional DOE techniques we would find effect of variables & identify conditions for which MPG is maximized.

Taguchi would suggest that we search for carb. design and engine disp. that mitigate the effects that tire press and driving speed variation have on the variation in MPG performance.

Before the experiment is performed, classify the variables as being either control or noise factors.



Let us consider another example: Injection molding - part shrinkage

<u>Variables</u>

- Control Factors set in engineering design - Gate Configuration
  Cavity Surface Finish
- Control Factors set at machine - ScrewSpeed,Holding Pressure
- Noise Factors - Raw Material

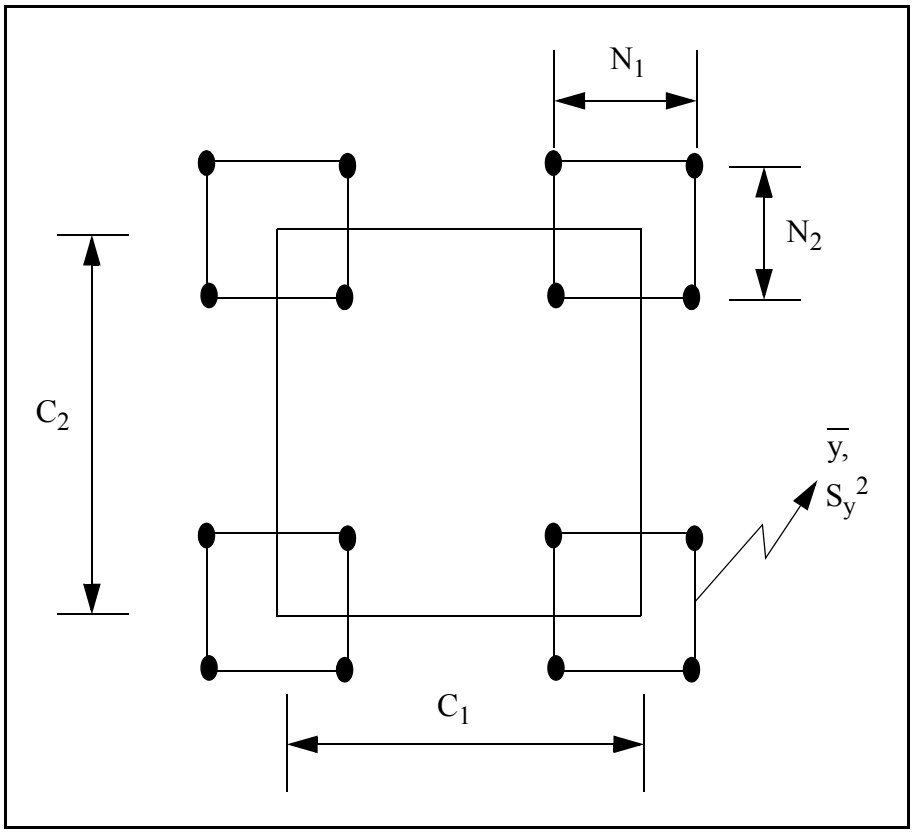
Moist Content
Mold Temp

Variables can be controlled if necessary - economic consequences.
All variables can be controlled, but some are easier to control than others - *"Degree-of-control: Idea"*.

- Do not make a priori decision about control/noise variables.
- Observe effect of variables -> judge the consequences of making noise/ control decision.

Parameter or Robust Design

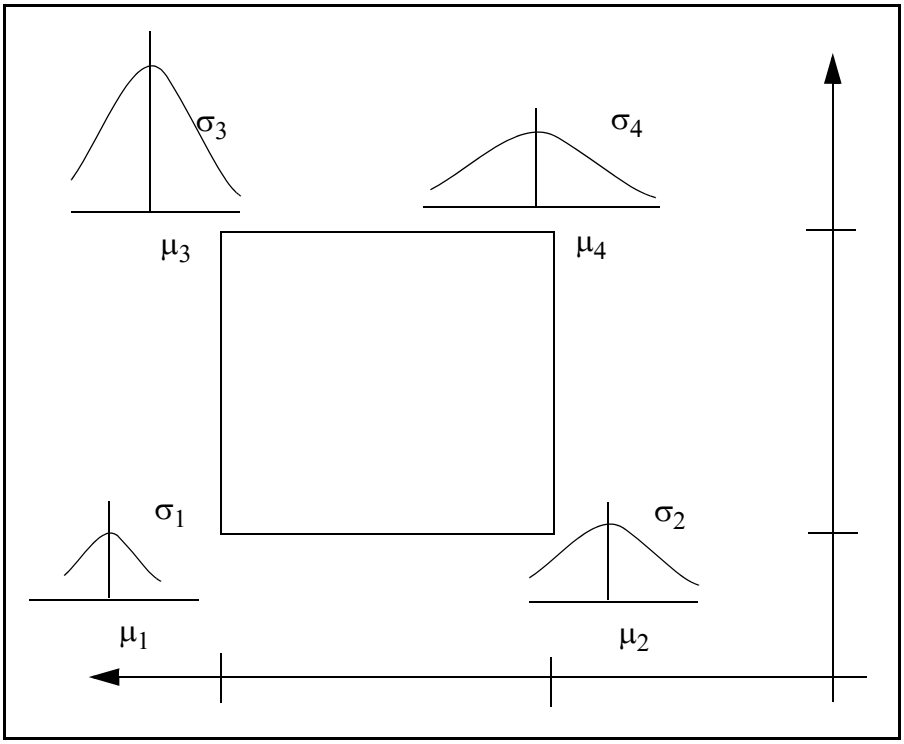
Taguchi suggests the use of inner/outer arrays.



Taguchi stresses the study of the physical/production environment. However, to conduct an experiment, we must purposely vary noise variables from low -> high level. Clearly we must be focusing on a somewhat experimental environment.

Taguchi suggests calculating a sample mean and variance for each combo of the control variables. Study the S/N = $\frac{\bar{y}}{Sy}$ ratio as a function of the control variables Pick the best S/N. Pick the winner approach.

How do mean and variance change as a function of the control variables?



Study all factors in a 2 level experiment equivalent mathematically to inner/outer array.

$\hat{y}$ = model for average response, $\mu_y = b_0 + b_1x_1 + b_2x_2 + \ldots$

To judge the impact of one of the variables as a noise variable, say X_1

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_{12}x_1x_2 + \ldots$$

$$E(\hat{y}) = b_0 + b_1E(x_1) + b_2E(x_2) + \ldots$$

$$\text{Var } (\hat{y}) = b_1^2 var(x_1) + \ldots$$