6σ

An Introduction

by

Dr. Habib Siddiqui, Master Black Belt
Global Six Sigma Process Leader
Rohm and Haas Company

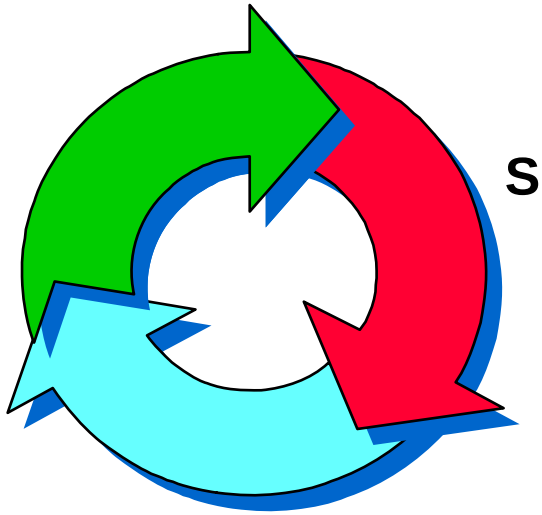
Competitive Realities of Our Time

The Global Business Climate

- **Fierce, global competition**
- **Accelerating pace of change**
- **New technologies**
- **Increasing customer demands - performance, quality, price, "solutions, not products," ...**

Cost:

Only low cost providers will survive



Speed:

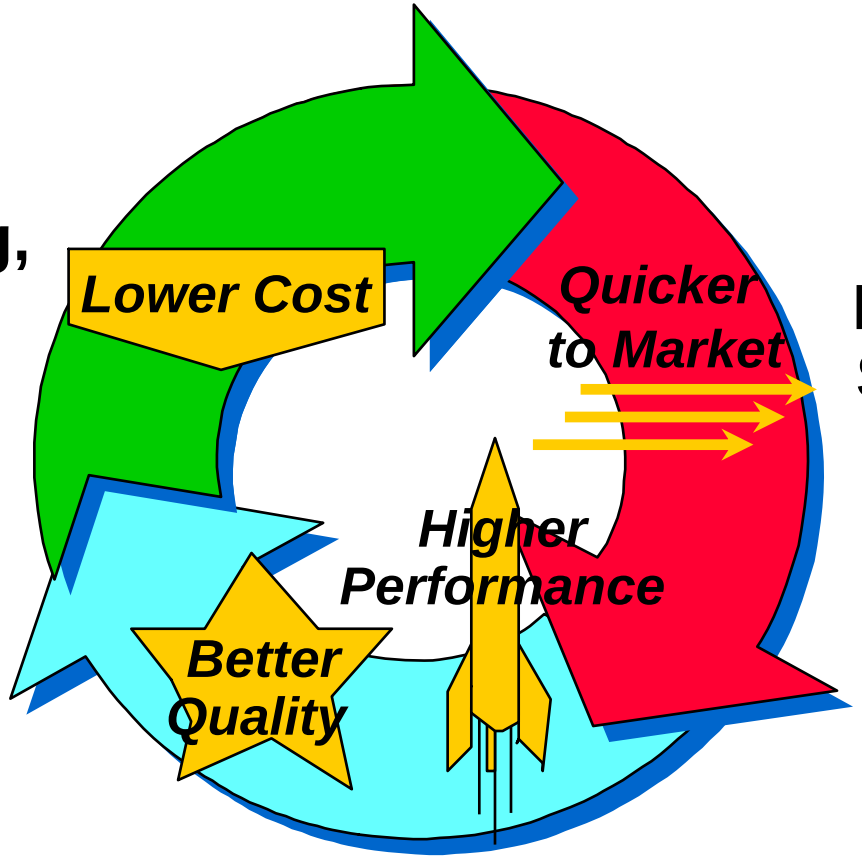
Short product life cycles, "e-business" mindset

Quality & Performance:

Higher expectations

New Initiatives to Meet the Realities

Cost
Target Costing, Globalization

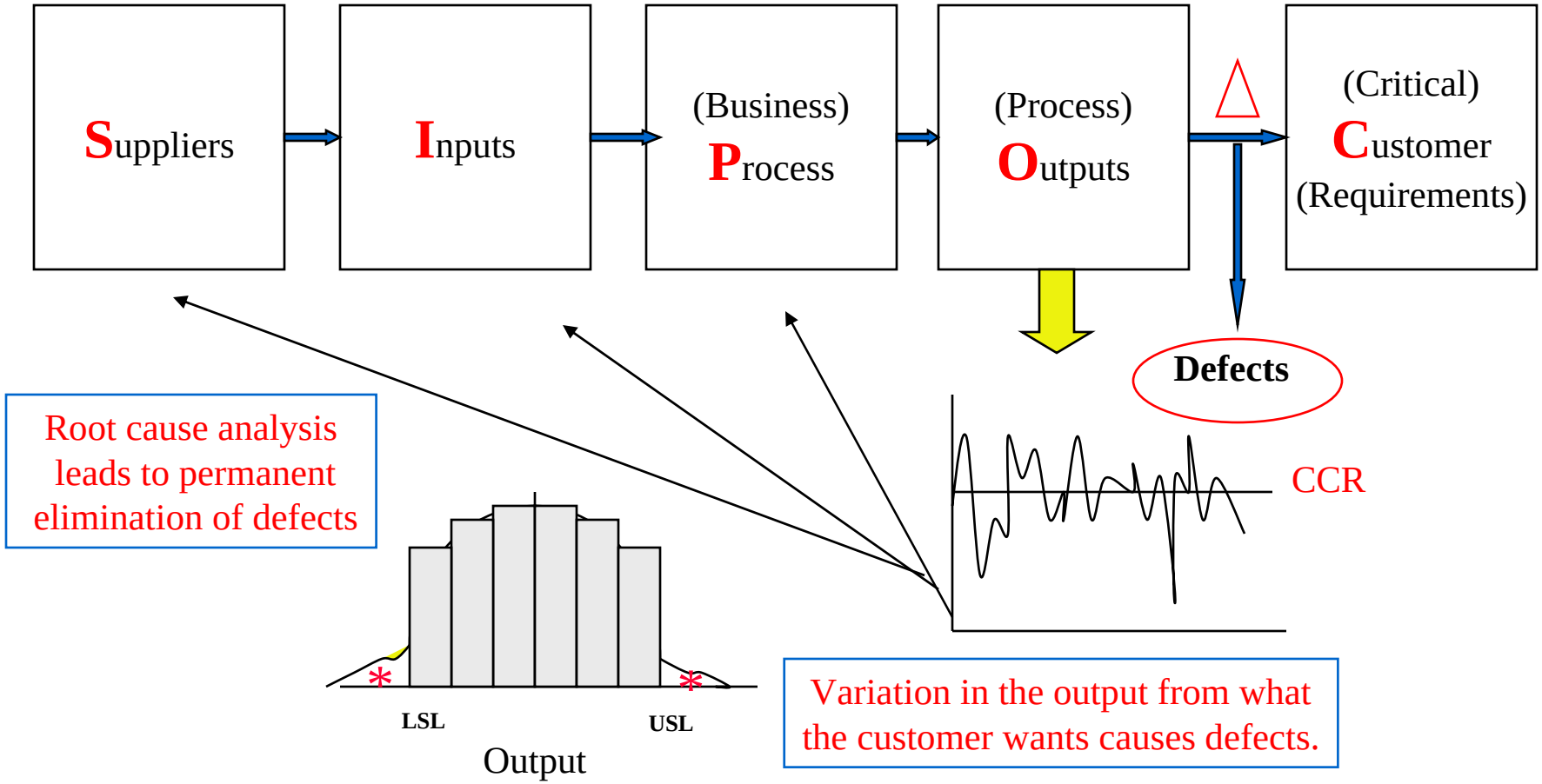


Speed
e-Engineering, Lean Enterprise, Streamlining SC

Quality & Performance
Six Sigma, Design for Six Sigma, Stage Gate/NPI, Risk Management

6σ

Everything we do is connected from …



Six sigma business improvement starts with SIPOC

6σ

The basic Six Sigma premise . . .

- **All processes have variability**
- **All variability has causes**
- **Typically only a few causes are significant**
- **To the degree that those causes can be understood - they can be controlled**
- **Designs must be robust to the effects of the process variation**
- **This is true for products, processes, services, information transfer, everything . . .**

. . .is that uncontrolled variation is the enemy

6σ

What is Six Sigma?

- Six Sigma is a powerful set of statistical and management tools and methodologies that can create dramatic increases in customer satisfaction, productivity and shareholder value for both service and manufacturing companies/organizations.
- It is a disciplined methodology of defining, measuring, analyzing, improving and controlling the quality in every product, process and transaction – with the ultimate goal of virtually eliminating all defects. (Jack Welch, GE)

6σ

History of Six Sigma

- Motorola (mid-'80s)
- GE – under Jack Welch (mid-'90s)
- Others doing it:
  - Dow, Witco (now Chemtura), DuPont, Rohm and Haas
  - Ford, GM
  - Johnson & Johnson, Merck (2000-01)
  - Maytag
  - Wal-Mart, Bank of America, Home Depot
  - Allied Signal (now Honeywell), Siemens, Intel
  - 3M, Kodak, Corning, Xerox, Avery-Dennison
  - and many others.
- Average six sigma project saves $250M ☺

Six Sigma: Philosophy

The Motorola School: (Show me the "Defect")

Relentless Defect Elimination

- Find and Remove Existing Defects
- Prevent New Defects

The GE School: (Show me the "$$$")

Relentless Pursuit of Financial Opportunities

- Identify High Impact Projects
- Use Six Sigma Methodology to Optimize the Process
- Visible Bottom Line Impact

Six Sigma : Measurement

Sigma Level	% Good	Defective ppm
2	69.15 %	308,537
3	93.32 %	66,807
4	99.379 %	6,210
5	99.9767 %	233
6	99.99966 %	3.4

How Important is Quality?

If your water heater operated at Four Sigma performance, you'd be without hot water more than 54 hours each year.

At Six Sigma, you'd be without hot water less than two minutes a year!

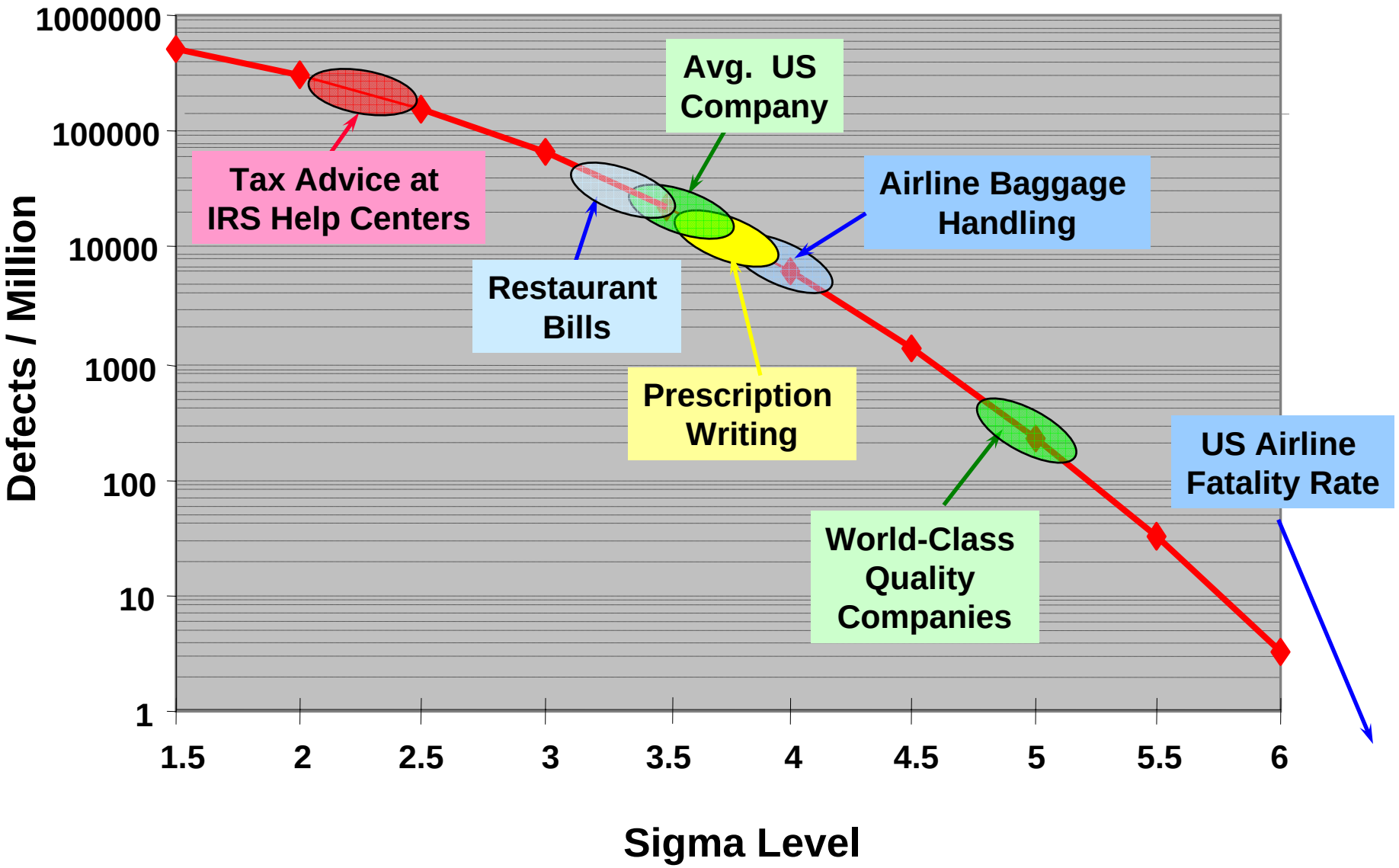
If your goal was 99% quality, you'd still have:

- **15 minutes of unsafe drinking water every day**
- **2 unsafe plane landings per day at most major airports**
- **20,000 pieces of lost mail every hour**
- **200,000 wrong drug prescriptions per year**
- **5,000 incorrect surgical operations per week**

(Ref: Control Engineering, Jan. 1999)

6σ

Sigma Levels of Some Activities



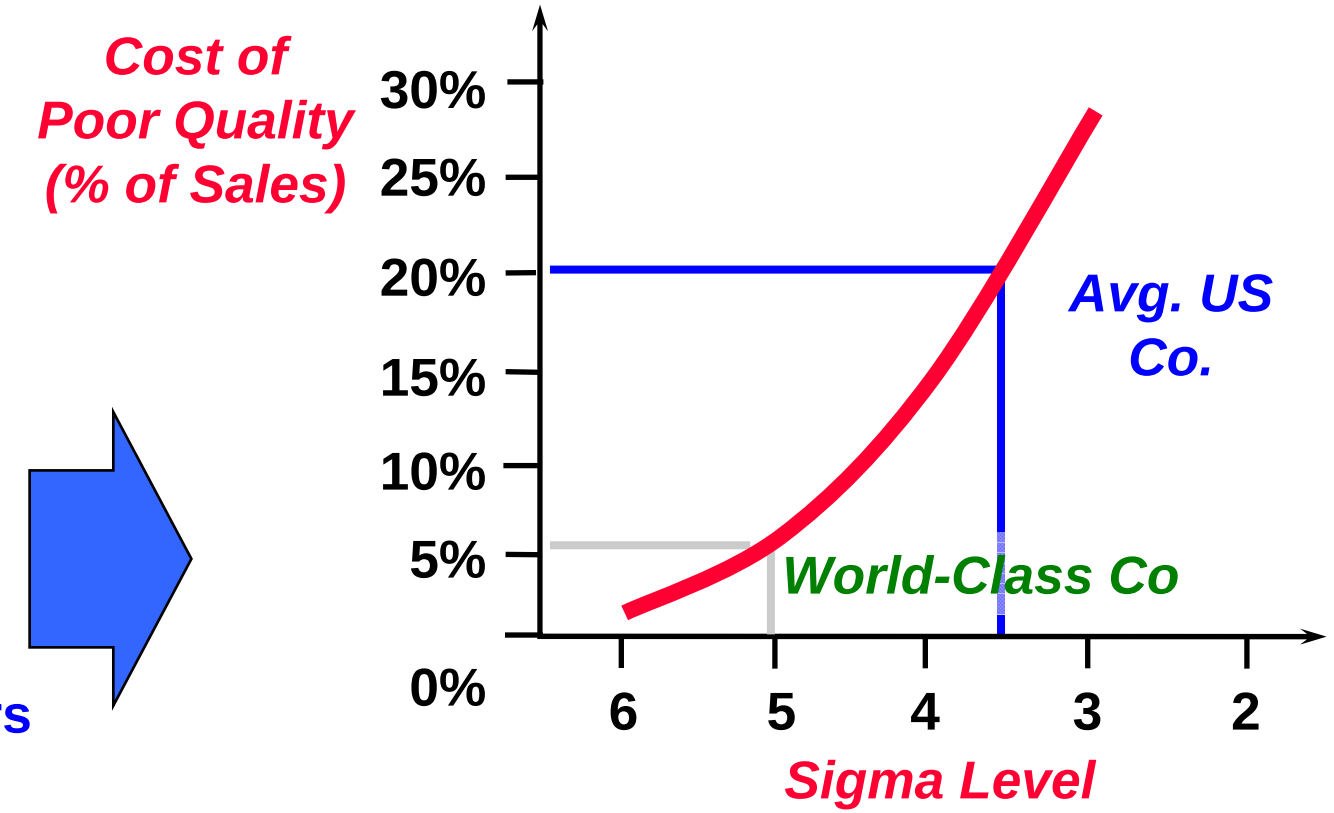
The High Cost of Poor Quality

Tangible Costs

- Inspection
- Scrap
- Rework
- Warranties

Intangible Costs

- Lost Customers
- Longer Cycles



Enormous opportunity

Six Sigma Methodology "Flavors"

- Six Sigma Process Optimization (DMAIC)
  - Manufacturing process
  - Business/service/transaction process
- Design for Six Sigma (DFSS)
  - new products
  - new processes
  - new services
  - Redesigning an existing product/service to meet entitlement

Six Sigma DMAIC Methodology

Six Sigma is information dependent.

- **D** — **D**efine what's important
- **M** — **M**easure how we're doing
- **A** — **A**nalyze what's wrong
- **I** — **I**mprove by fixing what's wrong
- **C** — **C**ontrol to guarantee performance

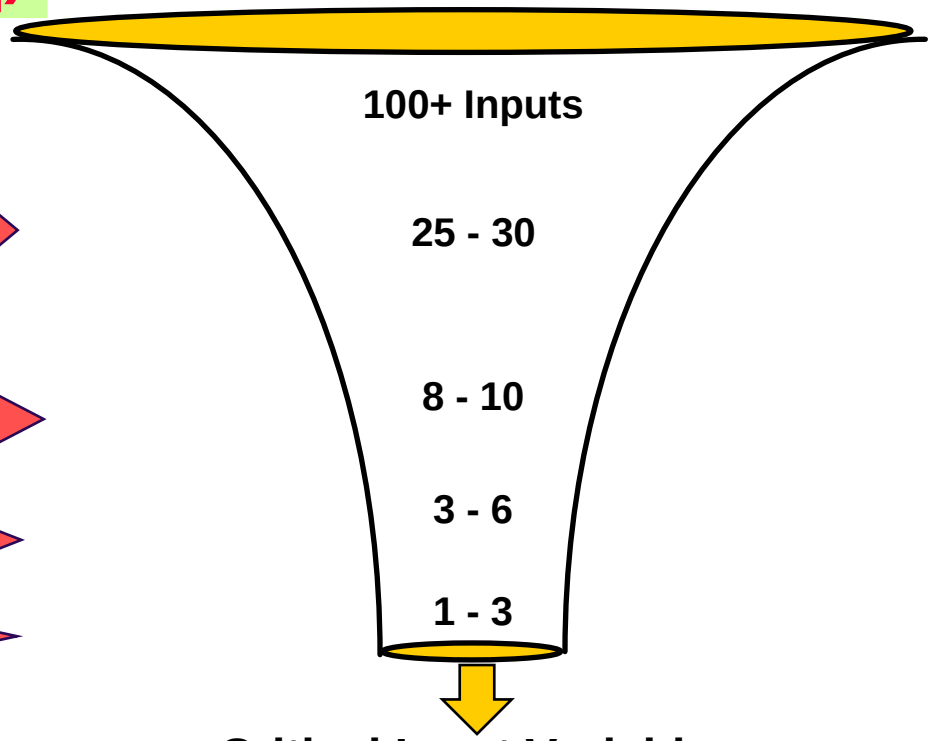
6σ

The Six Sigma Filtering Effect

Inexpensively, narrow in on fewer and fewer Variables, Saving more "expensive" tools for when we have fewer Variables

Output $Y = f(x_1, x_2, \ldots, x_n)$

All Possible Variables



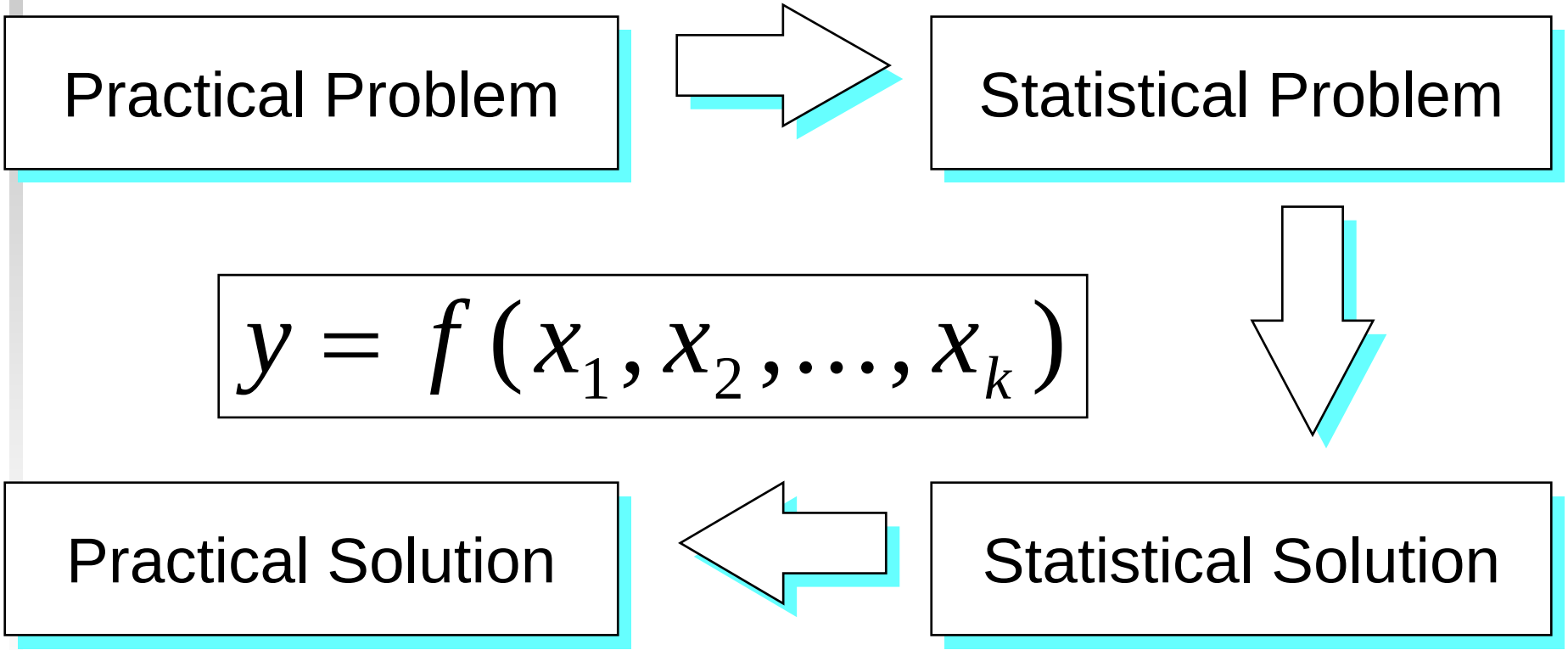
Critical Input Variables

	• Process Maps
MEASURE	• Capability Study • Measurement Study • C& E Matrix
ANALYZE	• FMEAs • Multi-Vari Studies
IMPROVE	• Design of Experiments (DOE)
CONTROL	• Control Plans
Sustain-Certify	• Confirm Benefits

$  $

6σ

Six Sigma: Conceptual Approach

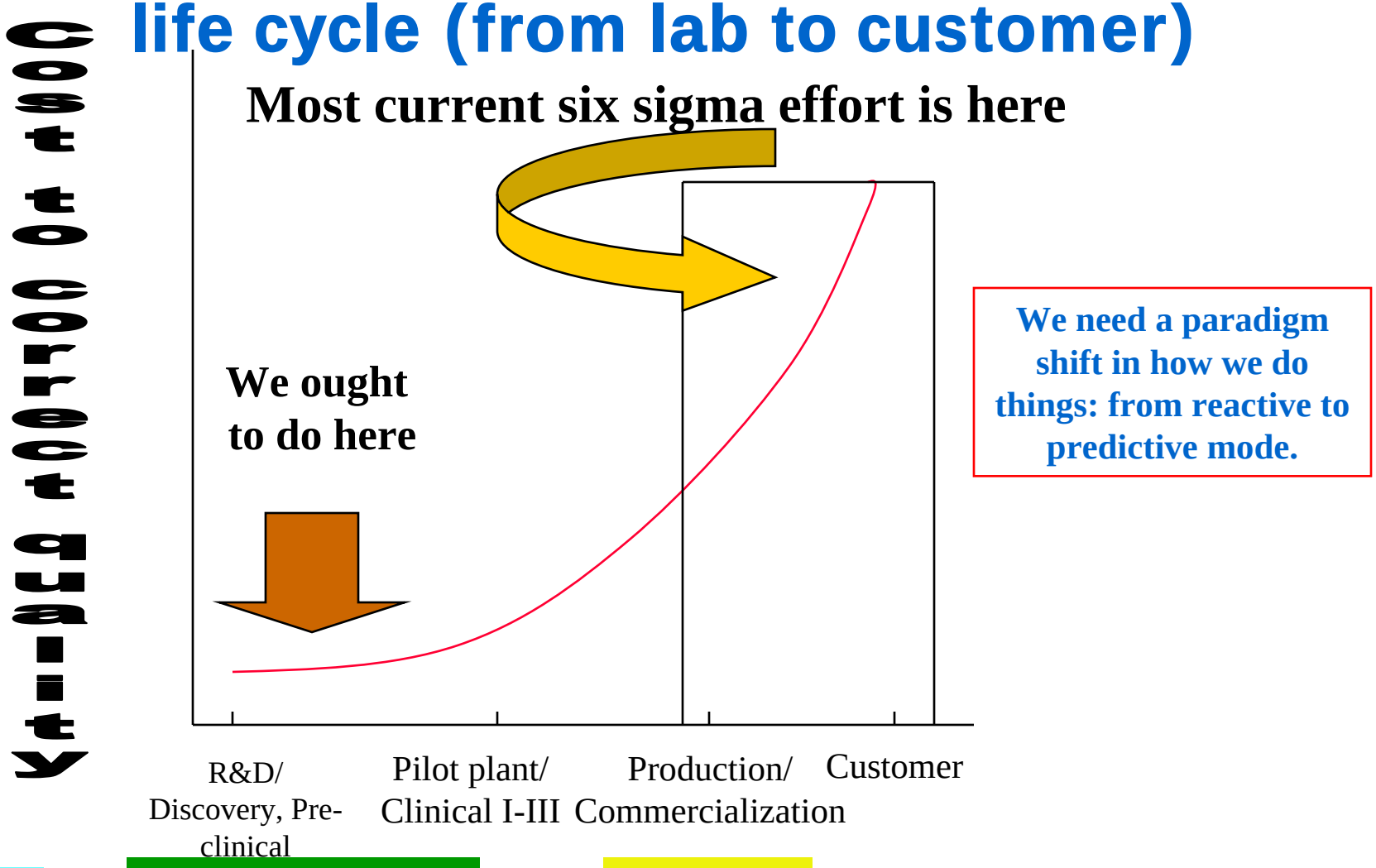


6σ

Design for six sigma (DFSS)

(Applicable to R&D/Tech Service)

Cost Of Poor Quality over the product life cycle (from lab to customer)



We need a paradigm shift in how we do things: from reactive to predictive mode.

Defects are:

Difficult to see/predict
Easy to fix

Easy to see
Costly to fix

May lose customers

6σ

How Does R&D Play in the Six Sigma Game?

- **R&D focuses on discovery or *innovation*, not process improvement**
- **Defects are not known (or difficult to see) for new, innovative designs**
- **Most new product quality problems are in *performance* and *reliability*, not *producibility***

- **Difficult to apply classic Six Sigma to R&D**
- **Need extension to new product creation - *DFSS!***

6σ

Why DFSS?

D-M-A-I-C has been around for over 10 years, but…

» Six Sigma Practices in Manufacturing is Not Enough

» Cannot Produce a Six Sigma Product via Mfg Alone

Up to 4.5σ ⇒ Achievable via Mfg Improvements

4.5σ –> 5σ ⇒ Law of Diminishing Returns in Mfg

The "5σ Wall"

5σ –> 6σ ⇒ Requires Product Designed for 6σ, ***DFSS***

Customers don't care about the Mfg Processes

Customers want Product Performance, Reliability & Durability

DFSS is Essential to Acheive Customer Satisfaction

Underlying Truism:Knowing what the customer needs

We don't know what we don't know,
we can't act on what we don't know,
we won't know until we search,
we won't search for what we don't question,
we won't question what we don't measure,
and hence we just don't know.

Customer Service 101: Know what is "good" to your customer … (VOC)

Ichiro Ishikawa:

"When I ask the designer what is a good car, what is a good refrigerator and what is a good synthetic fiber, most of them cannot answer. It is obvious they cannot produce good products.

You simply cannot design a good product or service if you do not know what "good" means to the customer.

The designer must create a map that moves the world of customer to the world of the designer"

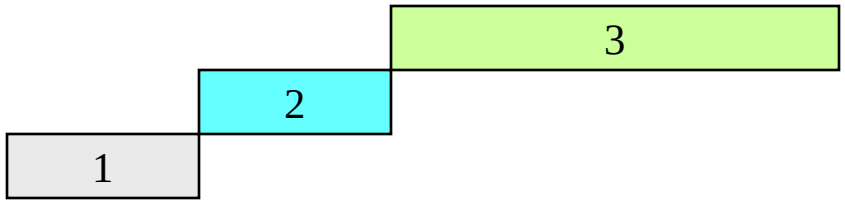
Customers: how important are they?

- **Customer loyalty for strategic partners is very important. Keeping an old customer happy is more fruitful than finding a new one. (**It is easy to retain five satisfied customers than to find a new one.)
- One happy customer tells three people, 1 unhappy customer tells 20.

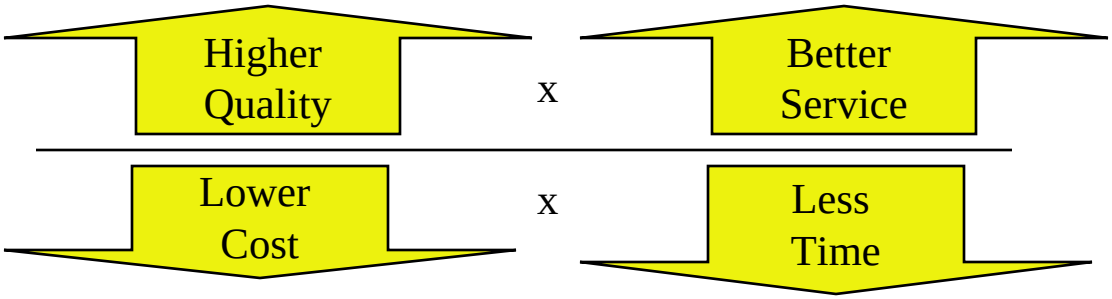
Voice of the Customer

Customer Satisfaction = f(Perception, Expectation)

Level 1 : Features and Cost
Level 2 : Quality
Level 3: Features, Cost, Quality, Delivery,…. Value added

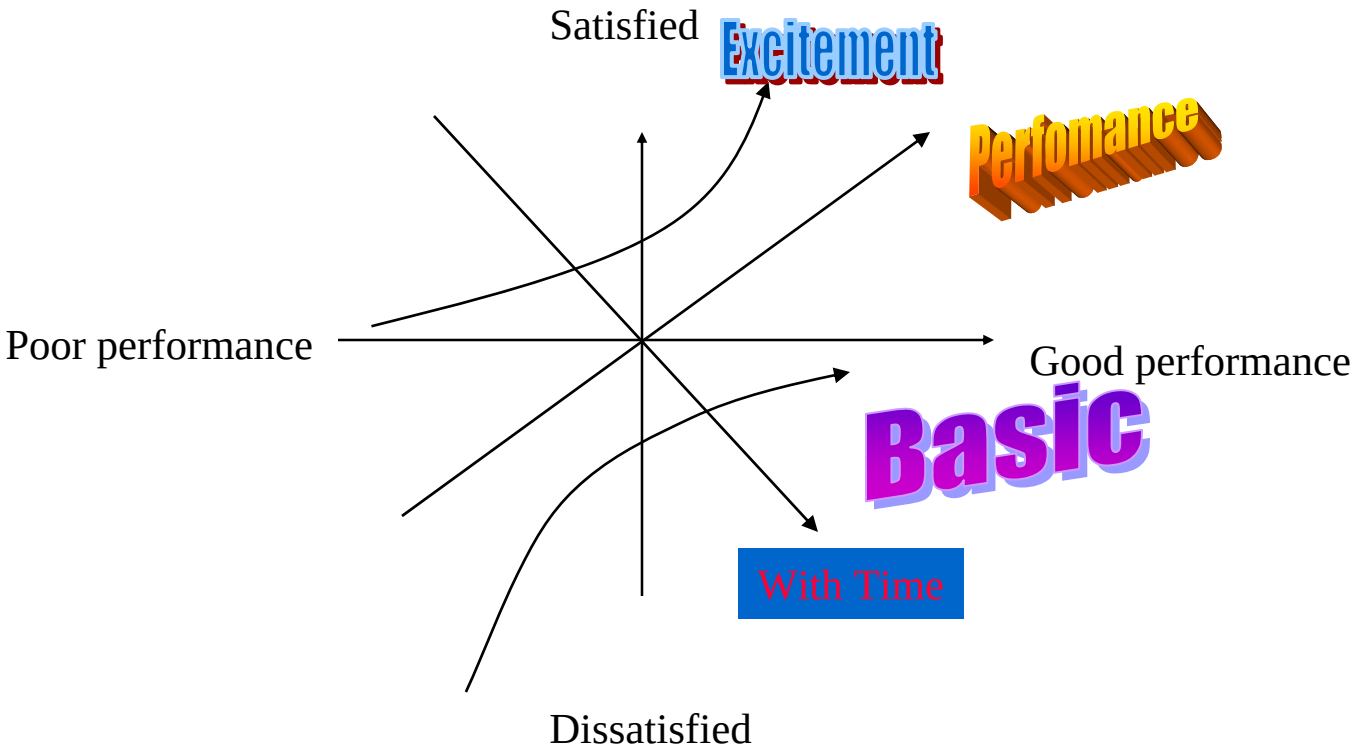


Customer value =



6σ

Kano Model (a 2-d concept of quality)



6σ

And we often do ….

- Insane things.

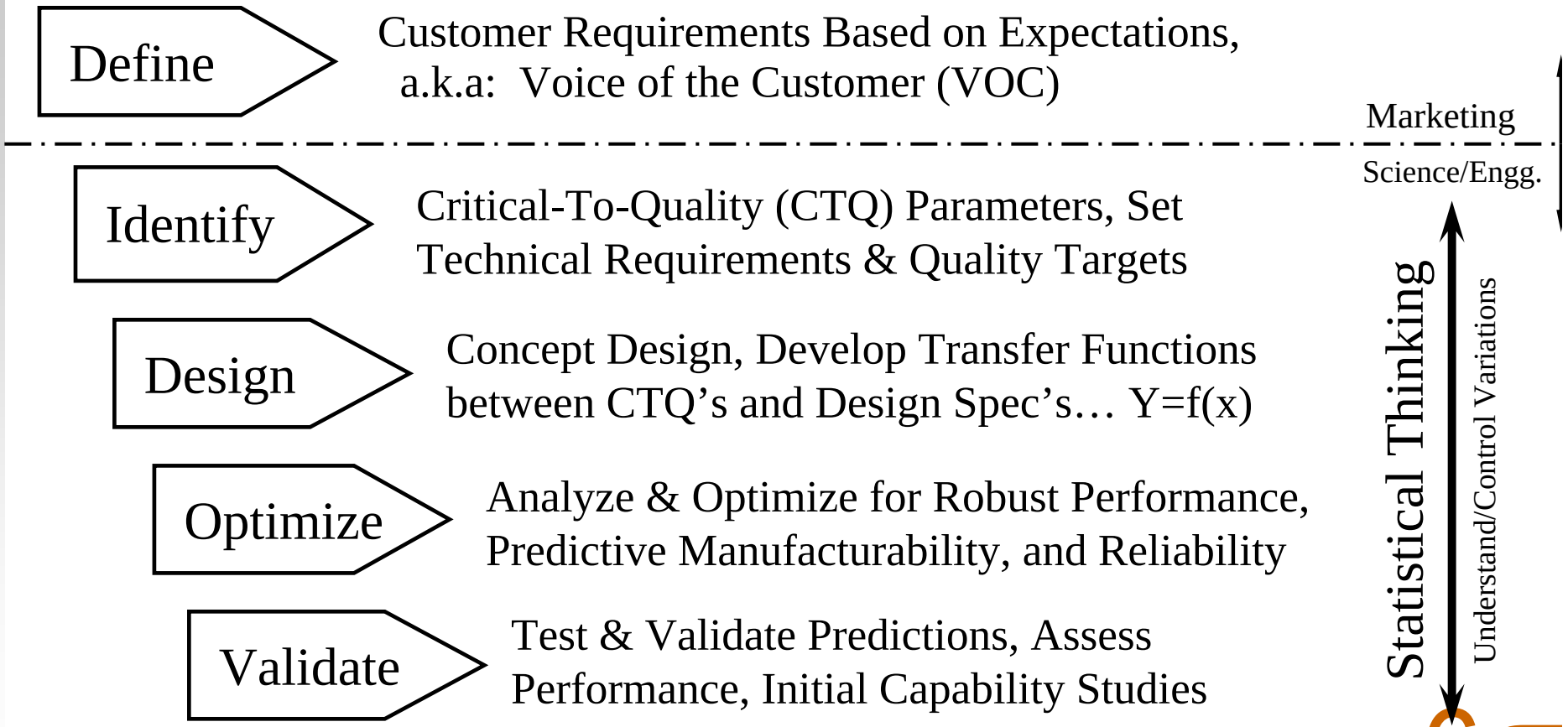
Insanity (definition):

Continue to do things we have always done and yet expect to get different results.

Six sigma is about doing things the right way

DFSS Overview: Alternative Roadmap

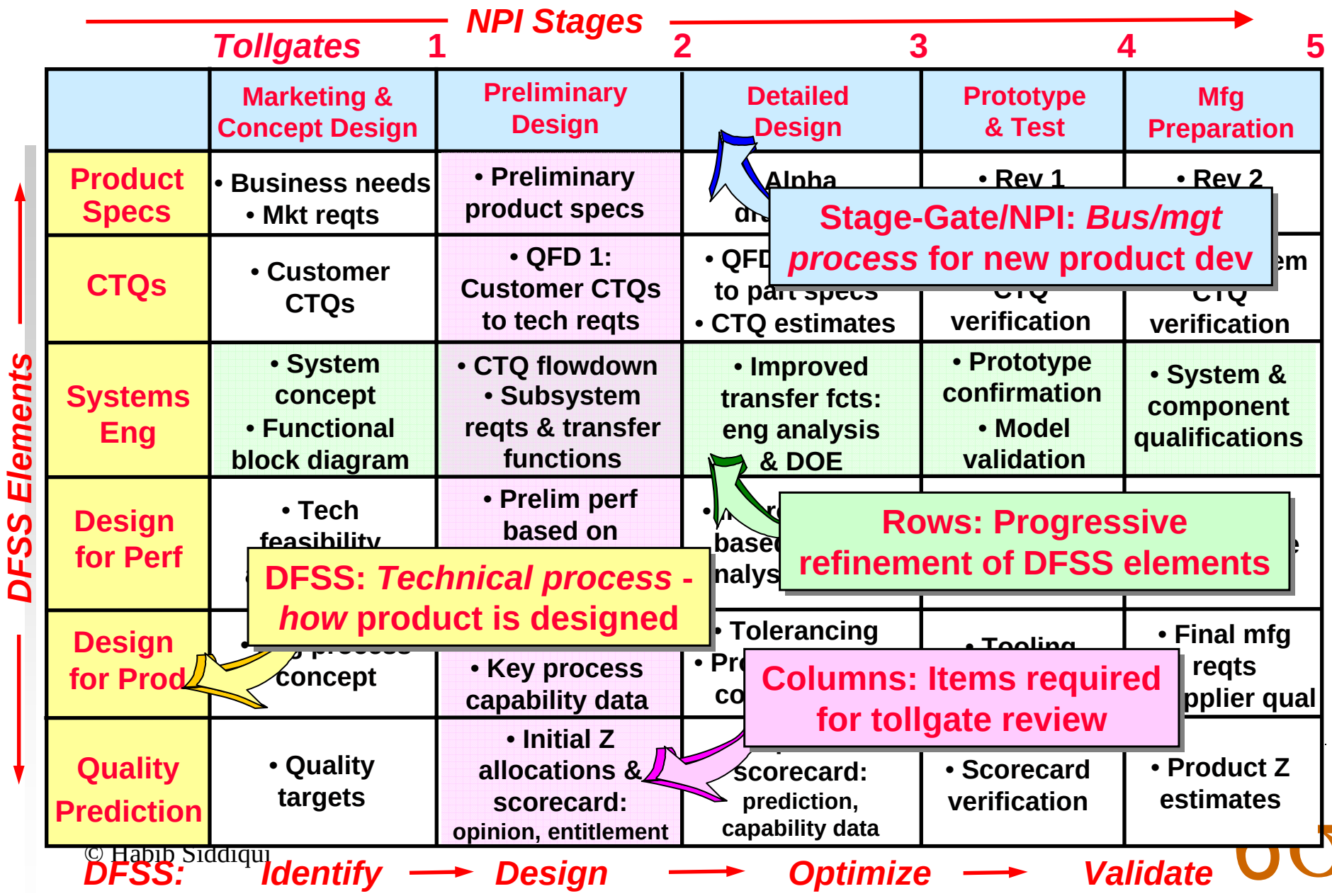
A Specific Product Design Methodology where Customer Requirements Dictate the Critical Parameters and the Variability of the Critical Parameters are Optimized for Predictive Product Performance, Manufacturability, Reliability and Durability.



What's Different About DFSS?

- Disciplined, comprehensive process
- Line of sight from customer CTQs to all design levels
- Statistical design to understand and reduce variation
- "New" tools: QFD, DOE, Robust Design, DFM, statistical tolerancing, multi-variable optimization, ...
- Quality prediction throughout development

Integrating DFSS with Stage-Gate / NPI



Practical Statistics

- *The long-range contribution of statistics depends not so much upon getting a lot of statisticians into industry as it does in creating a statistically minded generation of physicists, chemists, engineers, and others who will have a hand in developing and directing the production processes of tomorrow.*

  – W. A. Shewhart and W. E. Deming (1939)

Six Sigma …A simple approach

The right projects

+

The right people

+

The right roadmap and tools

+

The right support

=

The right results

Business Results of Using Six Sigma