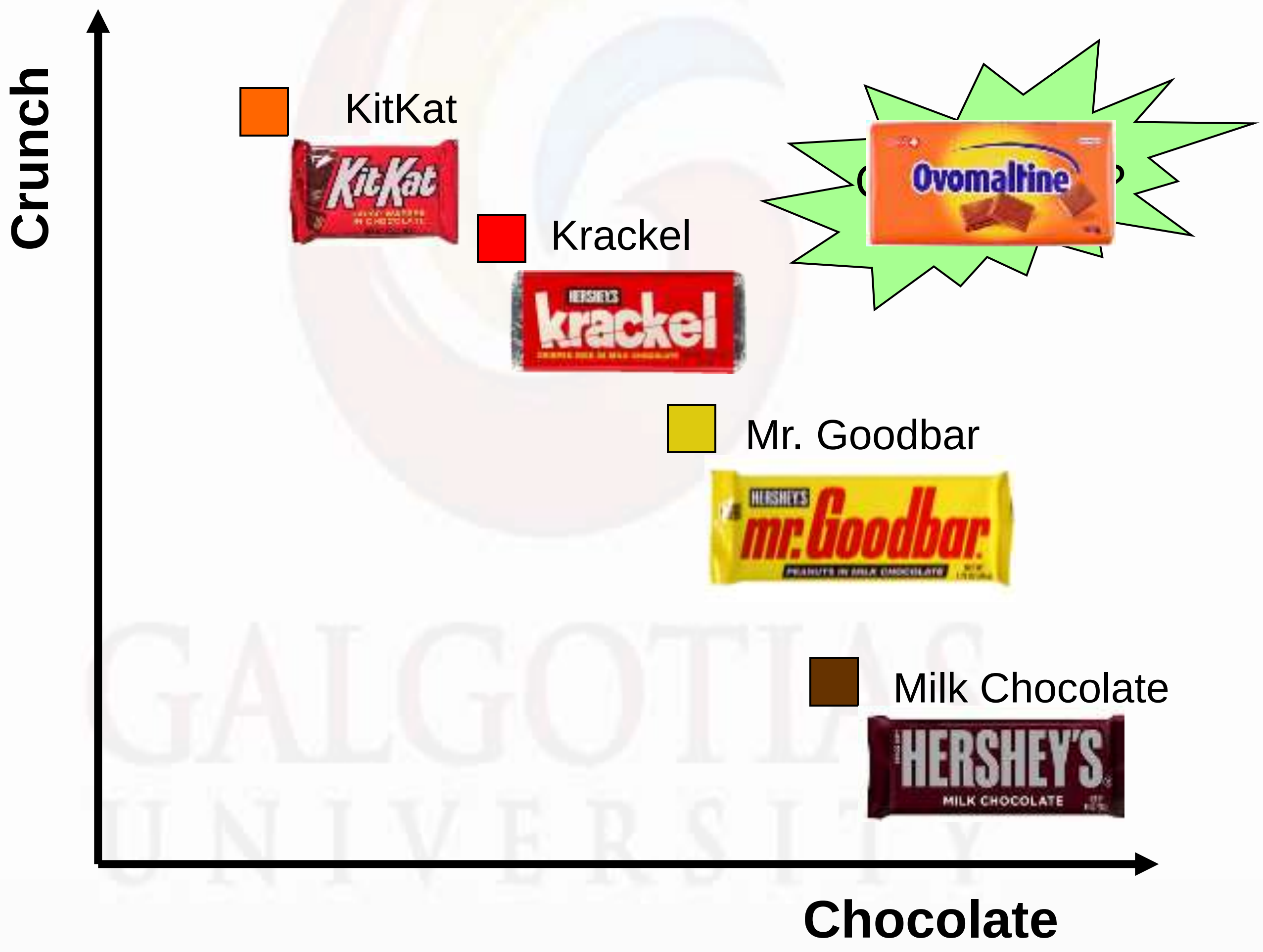
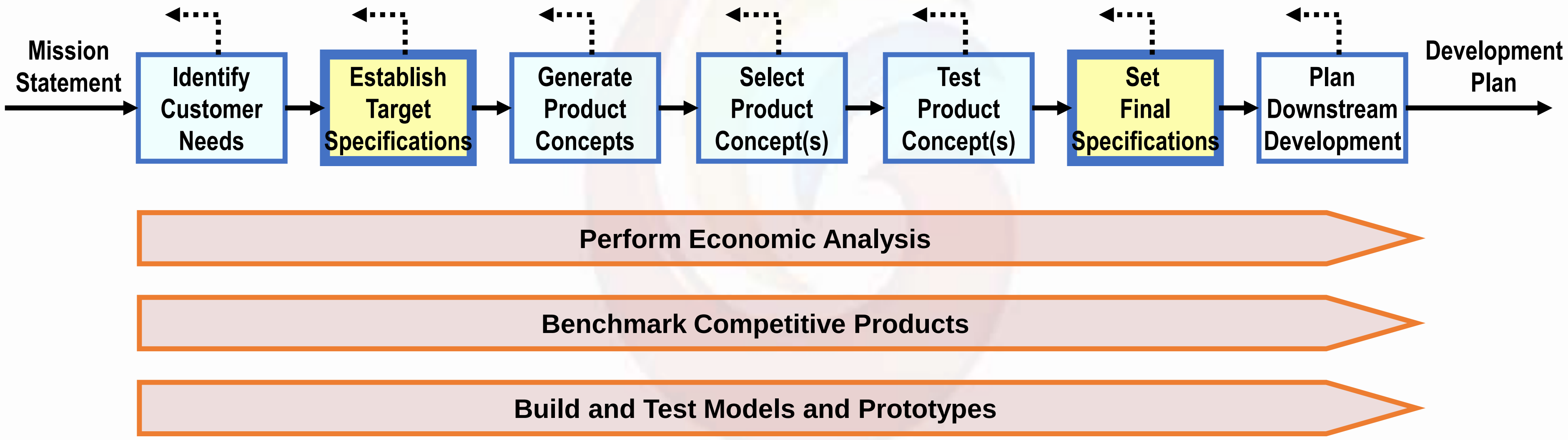
# Product Specifications

# Product Specifications

# Perceptual Mapping Exercise:
## Chocolate Product Specifications



# Concept Development Process




**Target Specs**

Based on customer needs and benchmarking

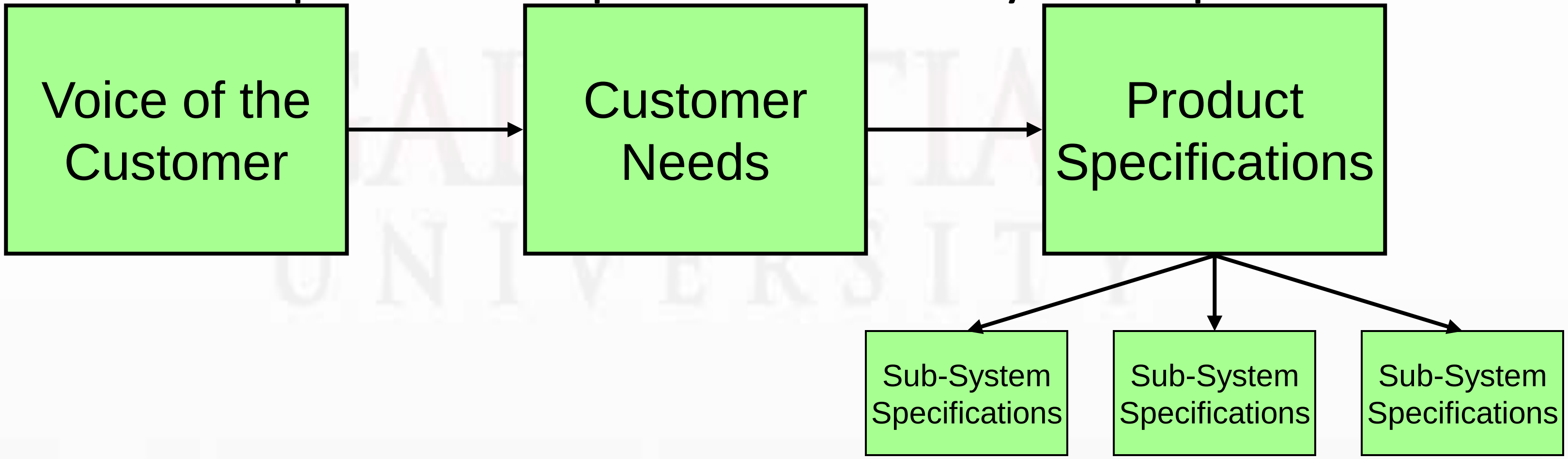
**Final Specs**

Based on selected concept, feasibility, models, testing, and trade-offs

# Terminology

Product requirements come in many forms:

- Customer Needs
  - Voice of the customer translated into proper form
- Product Specifications
  - Customer needs translated into measurable terms
- Sub-system Specifications
  - Product specs decomposed into sub-system specs



## Challenge:
## Translate Customer Needs into Product Specifications

- Customer needs are captured in the customer's language.
- Product specifications are in technical terms that can be measured.
- We must establish specs for each need.

Two questions for each one:

1. How will we measure it?
2. What is the right value?

# Product Requirements Example: Mountain Bike Suspension Fork

# Spec = Metric + Value(s) + Units

Examples:

| metric | value | units |
|---|---|---|
| • Total Mass | 8.5-10 | kg |
| • Cycles to Failure | >500k | cycles |
| • Unit Production Cost | <110 | $ |

# Start with the Customer Needs

| # | NEED | | Imp |
|---|---|---|---|
| 1 | The suspension | reduces vibration to the hands. | 3 |
| 2 | The suspension | allows easy traversal of slow, difficult terrain. | 2 |
| 3 | The suspension | enables high speed descents on bumpy trails. | 5 |
| 4 | The suspension | allows sensitivity adjustment. | 3 |
| 5 | The suspension | preserves the steering characteristics of the bike. | 4 |
| 6 | The suspension | remains rigid during hard cornering. | 4 |
| 7 | The suspension | is lightweight. | 4 |
| 8 | The suspension | provides stiff mounting points for the brakes. | 2 |
| 9 | The suspension | fits a wide variety of bikes, wheels, and tires. | 5 |
| 10 | The suspension | is easy to install. | 1 |
| 11 | The suspension | works with fenders. | 1 |
| 12 | The suspension | instills pride. | 5 |
| 13 | The suspension | is affordable for an amateur enthusiast. | 5 |
| 14 | The suspension | is not contaminated by water. | 5 |
| 15 | The suspension | is not contaminated by grunge. | 5 |
| 16 | The suspension | can be easily accessed for maintenance. | 3 |
| 17 | The suspension | allows easy replacement of worn parts. | 1 |
| 18 | The suspension | can be maintained with readily available tools. | 3 |
| 19 | The suspension | lasts a long time. | 5 |
| 20 | The suspension | is safe in a crash. | 5 |

# Establish Metrics and Units

| Metric # | Need #s | Metric | Imp | Units |
|---|---|---|---|---|
| 1 | 1,3 | Attenuation from dropout to handlebar at 10hz | 3 | dB |
| 2 | 2,6 | Spring pre-load | 3 | N |
| 3 | 1,3 | Maximum value from the Monster | 5 | g |
| 4 | 1,3 | Minimum descent time on test track | 5 | s |
| 5 | 4 | Damping coefficient adjustment range | 3 | N-s/m |
| 6 | 5 | Maximum travel (26in wheel) | 3 | mm |
| 7 | 5 | Rake offset | 3 | mm |
| 8 | 6 | Lateral stiffness at the tip | 3 | kN/m |
| 9 | 7 | Total mass | 4 | kg |
| 10 | 8 | Lateral stiffness at brake pivots | 2 | kN/m |
| 11 | 9 | Headset sizes | 5 | in |
| 12 | 9 | Steertube length | 5 | mm |
| 13 | 9 | Wheel sizes | 5 | list |
| 14 | 9 | Maximum tire width | 5 | in |
| 15 | 10 | Time to assemble to frame | 1 | s |
| 16 | 11 | Fender compatibility | 1 | list |
| 17 | 12 | Instills pride | 5 | subj |
| 18 | 13 | Unit manufacturing cost | 5 | US$ |
| 19 | 14 | Time in spray chamber w/o water entry | 5 | s |
| 20 | 15 | Cycles in mud chamber w/o contamination | 5 | k-cycles |
| 21 | 16,17 | Time to disassemble/assemble for maintenance | 3 | s |
| 22 | 17,18 | Special tools required for maintenance | 3 | list |
| 23 | 19 | UV test duration to degrade rubber parts | 5 | hours |
| 24 | 19 | Monster cycles to failure | 5 | cycles |
| 25 | 20 | Japan Industrial Standards test | 5 | binary |
| 26 | 20 | Bending strength (frontal loading) | 5 | MN |

# Metrics Exercise: Ballpoint Pen

Customer Need:
*The pen writes smoothly.*

How would you translate this need statement into metrics?
For each metric, state the appropriate units.

# Metrics Exercise: Ballpoint Pen

Customer Need:
*The pen writes smoothly.*

| | Metric (units) |
|---|---|
| 1 | Variation in line thickness (mm) |
| 2 | Variation in ink coverage (cc/mm2) |
| 3 | Functional range of writing force (N) |
| 4 | Functional range of writing velocity (mm/sec) |
| 5 | Functional range of pen angle from vertical (deg) |
| 6 | Variation in resistance to translational motion (N) |
| 7 | The pen feels comfortable (subj) |

# Metrics Exercise:
# Bike Locks

# Customer Quote

- How do you carry something this heavy?

## ➘ Customer Need

- The lock is lightweight.

## ➘ Metric?

# Customer Quote

- Some locks are just a pain. It takes too long to lock up.

## ➘ Customer Need

- The lock installs quickly to secure the bike.

## ➘ Metric?

# Customer Quote

- I wrap cushy tape around my lock to keep it from scratching my bike.

## ➘ Customer Need

- The lock protects the bicycle's finish.

## ➘ Metric?

## Customer Quote

- The lock doesn't protect all parts of the bicycle.

## ➘ Customer Need

- The lock protects the saddle, wheels, and other accessories.

## ➘ Metric?

# Two Ways to Benchmark Product Requirements

- Benchmark competitive products based on the customer needs.
- Benchmark competitive products based on the metrics established.

- Questions:
  - Which is the right way to do it?
  - What if they differ?

# Benchmark on Customer Needs

| # | NEED | | Imp | ST Tritrack | Maniray 2 | Rox Tahx Quadra | Rox Tahx Ti 21 | Tonka Pro | Gunhill Head Shox |
|---|---|---|---|---|---|---|---|---|---|
| 1 | The suspension | reduces vibration to the hands. | 3 | • | •••• | •• | ••••• | •• | ••• |
| 2 | The suspension | allows easy traversal of slow, difficult terrain. | 2 | •• | •••• | ••• | ••••• | ••• | ••••• |
| 3 | The suspension | enables high speed descents on bumpy trails. | 5 | • | ••••• | •• | ••••• | •• | ••• |
| 4 | The suspension | allows sensitivity adjustment. | 3 | • | •••• | •• | ••••• | •• | ••• |
| 5 | The suspension | preserves the steering characteristics of the bike. | 4 | •••• | •• | • | •• | ••• | ••••• |
| 6 | The suspension | remains rigid during hard cornering. | 4 | • | ••• | • | ••••• | • | ••••• |
| 7 | The suspension | is lightweight. | 4 | • | ••• | • | ••• | •••• | ••••• |
| 8 | The suspension | provides stiff mounting points for the brakes. | 2 | • | •••• | ••• | ••• | •• | ••••• |
| 9 | The suspension | fits a wide variety of bikes, wheels, and tires. | 5 | •••• | ••••• | ••• | ••••• | ••• | • |
| 10 | The suspension | is easy to install. | 1 | •••• | ••••• | •••• | •••• | ••••• | • |
| 11 | The suspension | works with fenders. | 1 | ••• | • | • | • | • | ••••• |
| 12 | The suspension | instills pride. | 5 | • | •••• | ••• | ••••• | ••• | ••••• |
| 13 | The suspension | is affordable for an amateur enthusiast. | 5 | ••••• | • | ••• | • | ••• | •• |
| 14 | The suspension | is not contaminated by water. | 5 | • | ••• | •••• | •••• | •• | ••••• |
| 15 | The suspension | is not contaminated by grunge. | 5 | • | ••• | • | •••• | •• | ••••• |
| 16 | The suspension | can be easily accessed for maintenance. | 3 | •••• | ••••• | •••• | •••• | ••••• | • |
| 17 | The suspension | allows easy replacement of worn parts. | 1 | •••• | ••••• | •••• | •••• | ••••• | • |
| 18 | The suspension | can be maintained with readily available tools. | 3 | ••••• | ••••• | ••••• | ••••• | •• | • |
| 19 | The suspension | lasts a long time. | 5 | ••••• | ••••• | ••••• | ••• | ••••• | • |
| 20 | The suspension | is safe in a crash. | 5 | ••••• | ••••• | ••••• | ••••• | ••••• | ••••• |

# Benchmark on Metrics

| Metric # | Need #s | Metric | Imp | Units | ST Tritrack | Maniray 2 | Rox Tahx Quadra | Rox Tahx Ti 21 | Tonka Pro | Gunhill Head Shox |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1,3 | Attenuation from dropout to handlebar at 10hz | 3 | dB | 8 | 15 | 10 | 15 | 9 | 13 |
| 2 | 2,6 | Spring pre-load | 3 | N | 550 | 760 | 500 | 710 | 480 | 680 |
| 3 | 1,3 | Maximum value from the Monster | 5 | g | 3.6 | 3.2 | 3.7 | 3.3 | 3.7 | 3.4 |
| 4 | 1,3 | Minimum descent time on test track | 5 | s | 13 | 11.3 | 12.6 | 11.2 | 13.2 | 11 |
| 5 | 4 | Damping coefficient adjustment range | 3 | N-s/m | 0 | 0 | 0 | 200 | 0 | 0 |
| 6 | 5 | Maximum travel (26in wheel) | 3 | mm | 28 | 48 | 43 | 46 | 33 | 38 |
| 7 | 5 | Rake offset | 3 | mm | 41.5 | 39 | 38 | 38 | 43.2 | 39 |
| 8 | 6 | Lateral stiffness at the tip | 3 | kN/m | 59 | 110 | 85 | 85 | 65 | 130 |
| 9 | 7 | Total mass | 4 | kg | 1.409 | 1.385 | 1.409 | 1.364 | 1.222 | 1.1 |
| 10 | 8 | Lateral stiffness at brake pivots | 2 | kN/m | 295 | 550 | 425 | 425 | 325 | 650 |
| 11 | 9 | Headset sizes | 5 | in | 1.000<br>1.125 | 1.000<br>1.125<br>1.250 | 1.000<br>1.125 | 1.000<br>1.125<br>1.250 | 1.000<br>1.125 | NA |
| 12 | 9 | Steertube length | 5 | mm | 150<br>180<br>210<br>230<br>255 | 140<br>165<br>190<br>215 | 150<br>170<br>190<br>210 | 150<br>170<br>190<br>210<br>230 | 150<br>190<br>210<br>220 | NA |
| 13 | 9 | Wheel sizes | 5 | list | 26in | 26in | 26in | 26in<br>700C | 26in | 26in |
| 14 | 9 | Maximum tire width | 5 | in | 1.5 | 1.75 | 1.5 | 1.75 | 1.5 | 1.5 |
| 15 | 10 | Time to assemble to frame | 1 | s | 35 | 35 | 45 | 45 | 35 | 85 |
| 16 | 11 | Fender compatibility | 1 | list | Zefal | none | none | none | none | all |
| 17 | 12 | Instills pride | 5 | subj | 1 | 4 | 3 | 5 | 3 | 5 |
| 18 | 13 | Unit manufacturing cost | 5 | US$ | 65 | 105 | 85 | 115 | 80 | 100 |
| 19 | 14 | Time in spray chamber w/o water entry | 5 | s | 1300 | 2900 | >3600 | >3600 | 2300 | >3600 |
| 20 | 15 | Cycles in mud chamber w/o contamination | 5 | k-cycles | 15 | 19 | 15 | 25 | 18 | 35 |
| 21 | 16,17 | Time to disassemble/assemble for maintenance | 3 | s | 160 | 245 | 215 | 245 | 200 | 425 |
| 22 | 17,18 | Special tools required for maintenance | 3 | list | hex | hex | hex | hex | long<br>hex | hex,<br>pin<br>wrnch |
| 23 | 19 | UV test duration to degrade rubber parts | 5 | hours | 400+ | 250 | 400+ | 400+ | 400+ | 250 |
| 24 | 19 | Monster cycles to failure | 5 | cycles | 500k+ | 500k+ | 500k+ | 480k | 500k+ | 330k |
| 25 | 20 | Japan Industrial Standards test | 5 | binary | pass | pass | pass | pass | pass | pass |
| 26 | 20 | Bending strength (frontal loading) | 5 | MN | 55 | 89 | 75 | 75 | 62 | 102 |

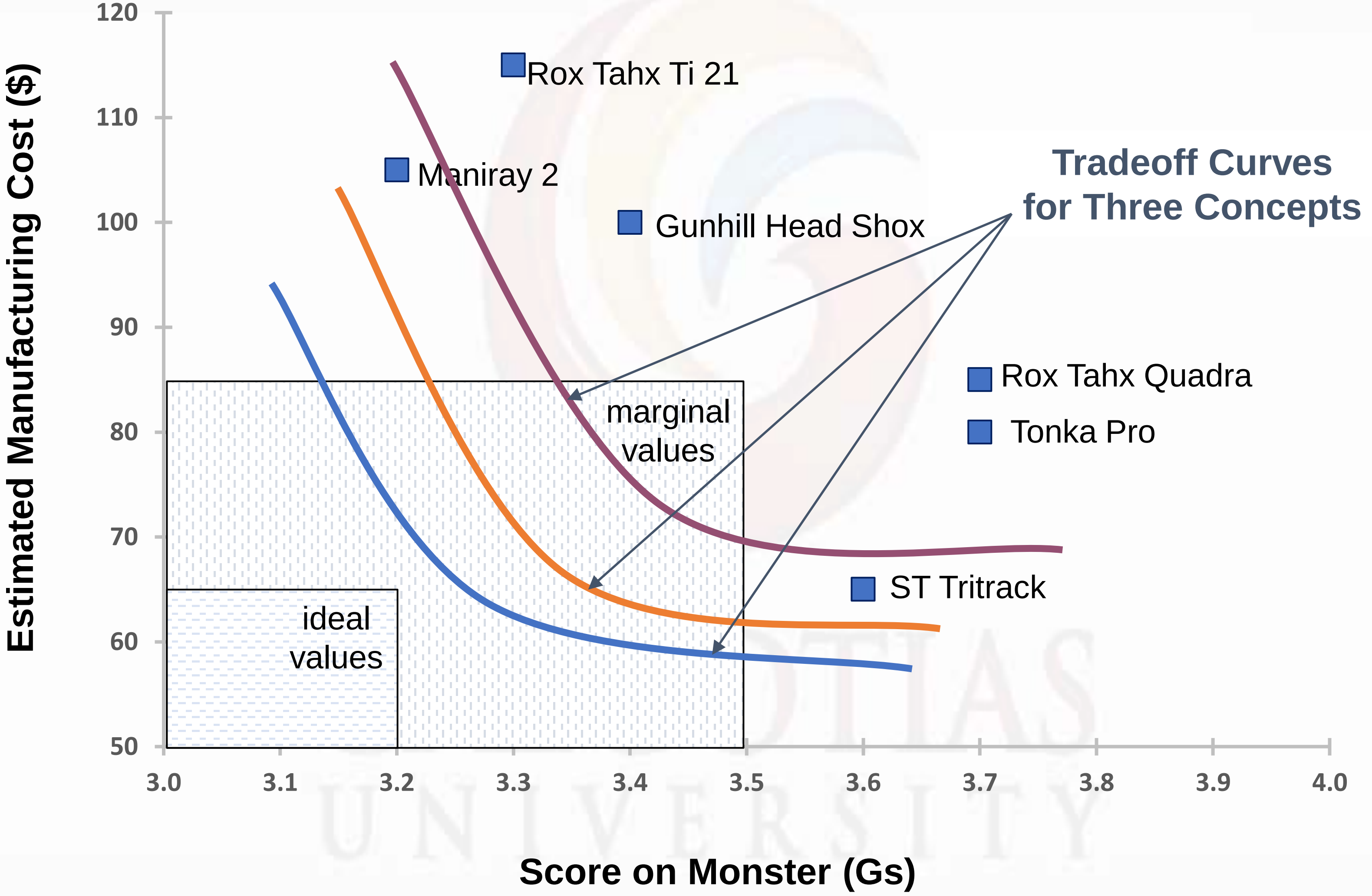
# Target Specs: Marginal and Ideal Values

| | Metric | Units | Marginal Value | Ideal Value |
|---|---|---|---|---|
| 1 | Attenuation from dropout to handlebar at 10hz | dB | >10 | >15 |
| 2 | Spring pre-load | N | 480 - 800 | 650 - 700 |
| 3 | Maximum value from the Monster | g | <3.5 | <3.2 |
| 4 | Minimum descent time on test track | s | <13.0 | <11.0 |
| 5 | Damping coefficient adjustment range | N-s/m | 0 | >200 |
| 6 | Maximum travel (26in wheel) | mm | 33 - 50 | 45 |
| 7 | Rake offset | mm | 37 - 45 | 38 |
| 8 | Lateral stiffness at the tip | kN/m | >65 | >130 |
| 9 | Total mass | kg | <1.4 | <1.1 |
| 10 | Lateral stiffness at brake pivots | kN/m | >325 | >650 |
| 11 | Headset sizes | in | 1.000<br>1.125 | 1.000<br>1.125<br>1.250 |
| 12 | Steertube length | mm | 150<br>170<br>190<br>210 | 150<br>170<br>190<br>210<br>230 |
| 13 | Wheel sizes | list | 26in | 26in<br>700c |
| 14 | Maximum tire width | in | >1.5 | >1.75 |
| 15 | Time to assemble to frame | s | <60 | <35 |
| 16 | Fender compatibility | list | none | all |
| 17 | Instills pride | subj | >3 | >5 |
| 18 | Unit manufacturing cost | US$ | <85 | <65 |
| 19 | Time in spray chamber w/o water entry | s | >2300 | >3600 |
| 20 | Cycles in mud chamber w/o contamination | k-cycles | >15 | >35 |
| 21 | Time to disassemble/assemble for maintenance | s | <300 | <160 |
| 22 | Special tools required for maintenance | list | hex | hex |
| 23 | UV test duration to degrade rubber parts | hours | >250 | >450 |
| 24 | Monster cycles to failure | cycles | >300k | >500k |
| 25 | Japan Industrial Standards test | binary | pass | pass |
| 26 | Bending strength (frontal loading) | MN | >70 | >100 |

# Dynamics of Product Specifications

- Target specs change for several reasons:
  - Customers change
  - Competitors respond
  - Technical capabilities improve
  - Designs evolve as details develop
  - Tradeoffs and conflicts become apparent
- Initially, we can set a range for specs.
- Then we learn what is feasible and can deliver.
- Finally, we commit to final point values.

# Specification Tradeoffs



# Set Final Specifications

| | METRIC | Units | Value |
|---|---|---|---|
| 1 | Attenuation from dropout to handlebar at 10hz | dB | >12 |
| 2 | Spring pre-load | N | 650 |
| 3 | Maximum value from the Monster | g | <3.4 |
| 4 | Minimum descent time on test track | s | <11.5 |
| 5 | Damping coefficient adjustment range | N-s/m | >100 |
| 6 | Maximum travel (26in wheel) | mm | 43 |
| 7 | Rake offset | mm | 38 |
| 8 | Lateral stiffness at the tip | kN/m | >75 |
| 9 | Total mass | kg | <1.4 |
| 10 | Lateral stiffness at brake pivots | kN/m | >425 |
| 11 | Headset sizes | in | 1.000<br>1.125 |
| 12 | Steertube length | mm | 150<br>170<br>190<br>210<br>230 |
| 13 | Wheel sizes | list | 26in |
| 14 | Maximum tire width | in | >1.75 |
| 15 | Time to assemble to frame | s | <45 |
| 16 | Fender compatibility | list | Zefal |
| 17 | Instills pride | subj | >4 |
| 18 | Unit manufacturing cost | US$ | <80 |
| 19 | Time in spray chamber w/o water entry | s | >3600 |
| 20 | Cycles in mud chamber w/o contamination | k-cycles | >25 |
| 21 | Time to disassemble/assemble for maintenance | s | <200 |
| 22 | Special tools required for maintenance | list | hex |
| 23 | UV test duration to degrade rubber parts | hours | >450 |
| 24 | Monster cycles to failure | cycles | >500k |
| 25 | Japan Industrial Standards test | binary | pass |
| 26 | Bending strength (frontal loading) | MN | >100 |

# When to Set the Final Specs

- Two Failure Modes:
  - Freezing specs too early.
  - Changing specs too late.
- Early Freeze
  - Allows downstream tasks to get started with firm input information
  - Facilitates downstream optimization (cost, performance, etc)
- Late Freeze
  - Allows better match with changing market (customers, competition)

- Question:
  - When to freeze the specifications?

- Answers:
  - Competing on cost, performance – freeze early
  - Competing on market match – freeze late

# Conflicts, Affordability, and Tradeoffs

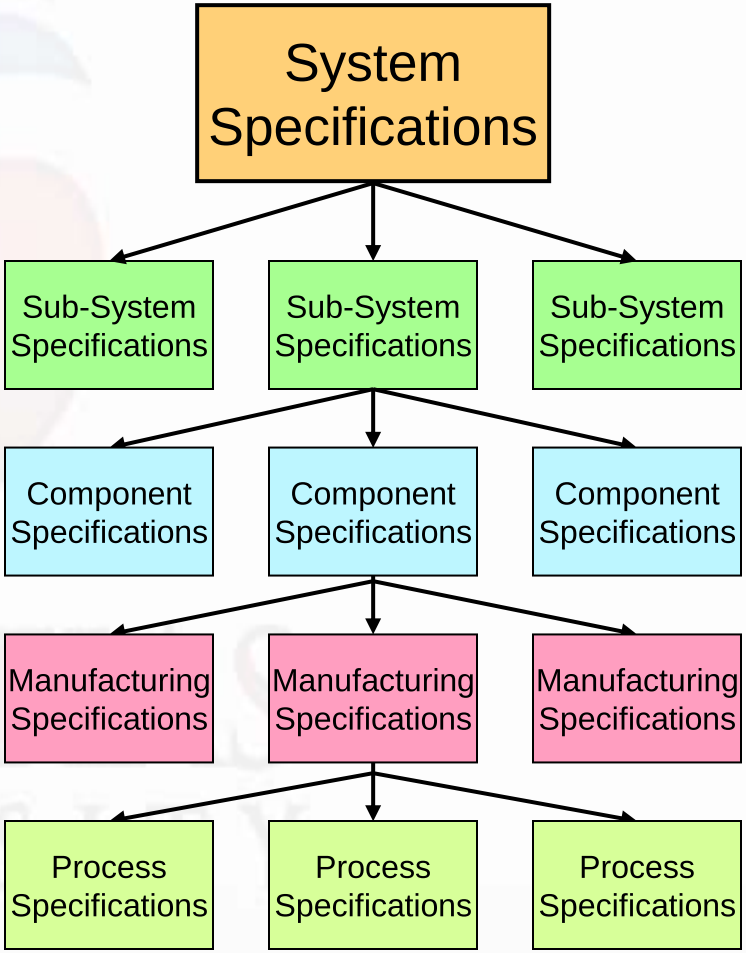
- Customers generally ask for more performance than is affordable.
- We can usually satisfy some target specs, but not all of them.

- Question: How does "target costing" help determine the specifications?

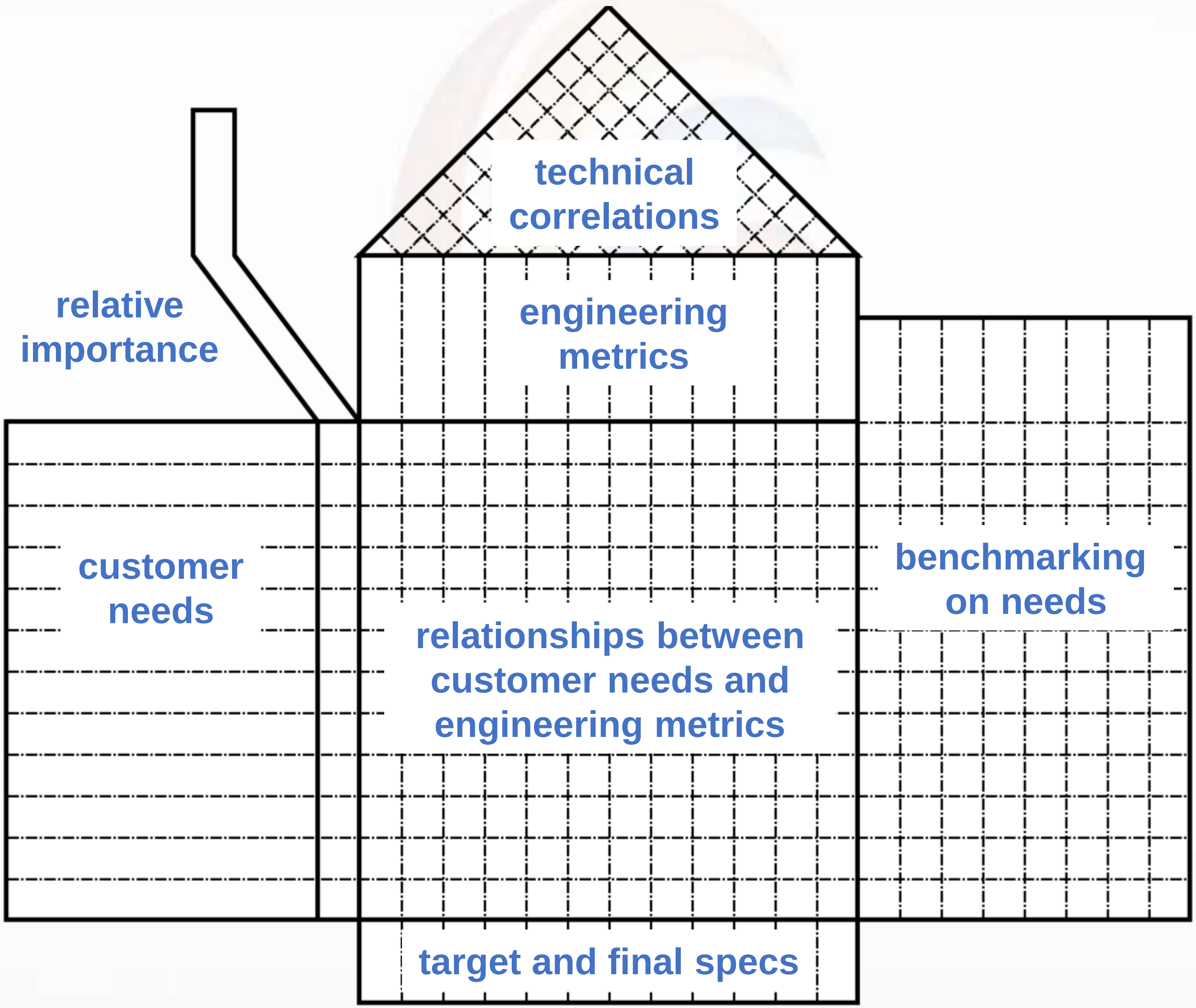
- Question: Can we compute the optimal set of specifications?

# Requirements Flow Down

- System-level specs determine whether we can meet the customer needs.
- Sub-system specs determine how to meet the system specs.
- Component specs determine how to meet the sub-system specs.
- Manufacturing specs determine how to meet the component specs.
- Process specs determine how to meet the component specs.



# Quality Function Deployment (House of Quality)



# Message

- Requirements planning is hard work.
- Learning the principles will help you understand how to get it right.
- Some tools and methods can help you do it more carefully and completely.
- It’s still hard work.

# References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# Thank you