Design Tool Review

MCHE 201 – Spring 2019

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Phases of Design

Phases of Design

1. Problem Understanding

Phases of Design

1. Problem Understanding
2. Specification Development

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design
4. Detail Design

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design
4. Detail Design
5. Production Specification

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design
4. Detail Design
5. Production Specification
6. Manufacture

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design
4. Detail Design
5. Production Specification
6. Manufacture
7. Disposal

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design
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5. Production Specification
6. Manufacture
7. Disposal

} Machine Design

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design

} What we've mostly talked about.

} The most nonlinear part.

4. Detail Design
5. Production Specification

} Machine Design

6. Manufacture
7. Disposal

Phases of Design

1. Problem Understanding
2. Specification Development
3. Conceptual Design

} What we've mostly talked about.

The most nonlinear part.

4. Detail Design
5. Production Specification

} Machine Design

6. Manufacture
7. Disposal

The entire process is iterative.

The Problem Understanding Form

- Cust. Req. are unambiguous and solution neutral
- Eng. Char. are *measurable* and solution neutral

		Engineering Characteristics
Customer Requirements	**Importance**	**Relationship Matrix**

The Problem Understanding Form

◉	Strong = 9
▣	Medium = 3
△	Weak = 1

Customer Requirements	Importance	Engineering Characteristics				
		◉		▣	△	
			◉	▣		▣
		◉	▣		△	
		▣	△			▣
			◉	△	◉	△

The Problem Understanding Form

◉	Strong = 9
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		Engineering Characteristics				
Customer Requirements	5	◉		▣	△	
	6		◉	▣		▣
	9	◉	▣		△	
	2	▣	△			▣
	1		◉	△	◉	△
Absolute Importance		132	92	34	17	25

The Problem Understanding Form

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		Engineering Characteristics					
Customer Requirements	5	◉		▣	△		
	6		◉	▣		▣	
	9	◉	▣		△		
	2	▣	△			▣	
	1		◉	△	◉	△	
Absolute Importance		132	92	34	17	25	sum 300

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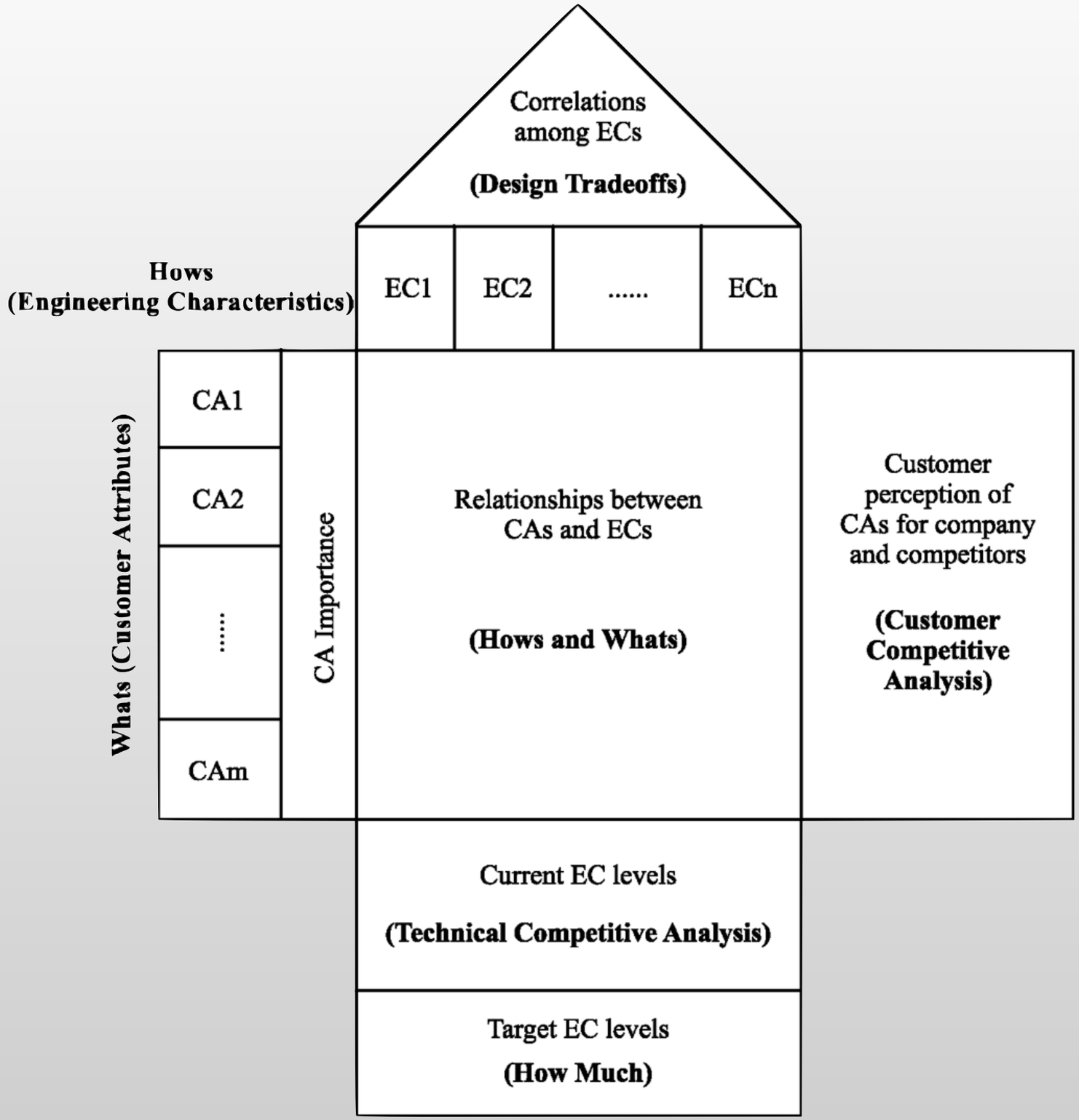
		Engineering Characteristics					
Customer Requirements	5	◉		▣	△		
	6		◉	▣		▣	
	9	◉	▣		△		
	2	▣	△			▣	
	1		◉	△	◉	△	
Absolute Importance		132	92	34	17	25	sum 300
Relative Importance		0.44	0.31	0.11	0.06	0.08	

The HoQ Correlation Matrix



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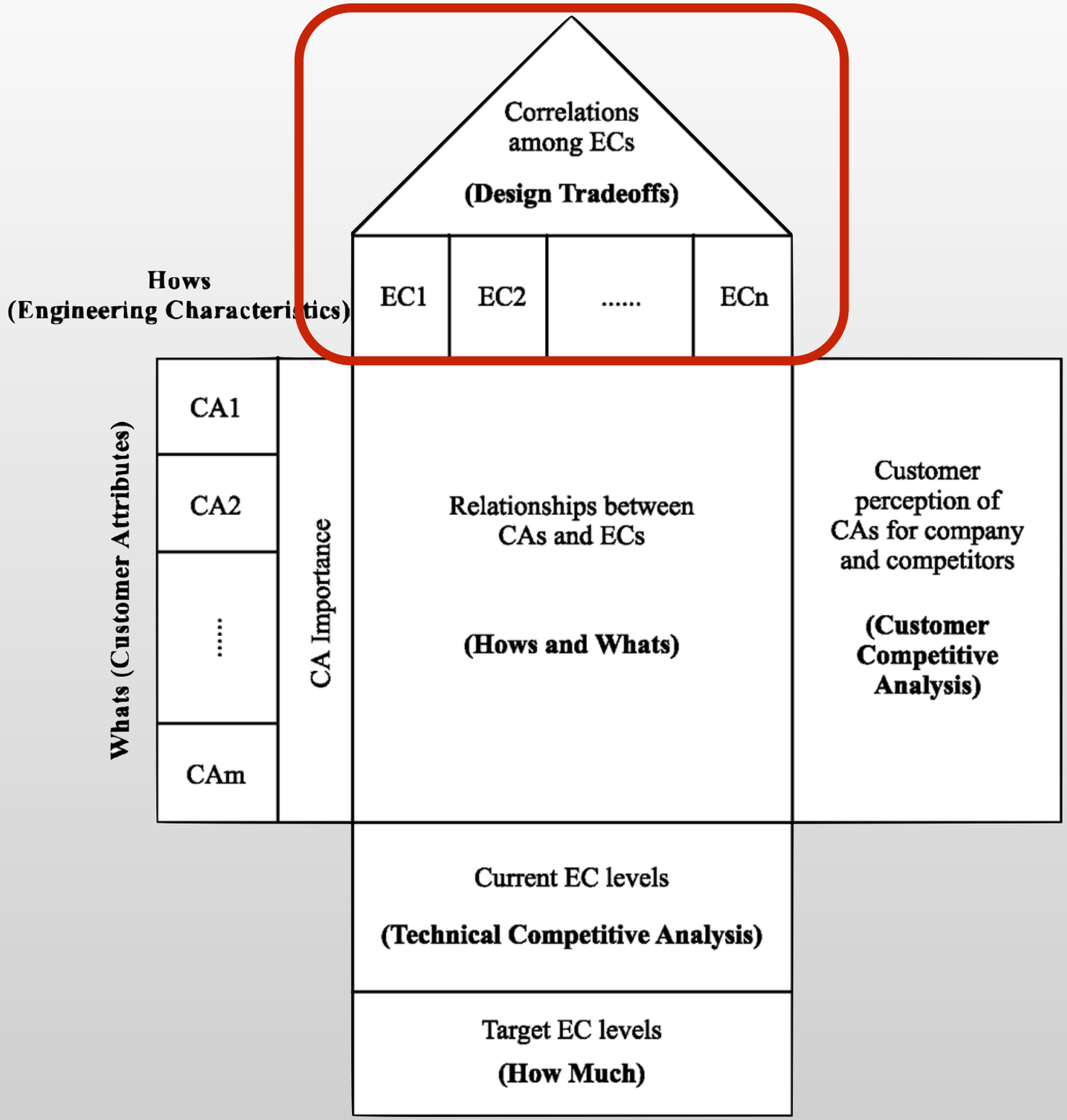
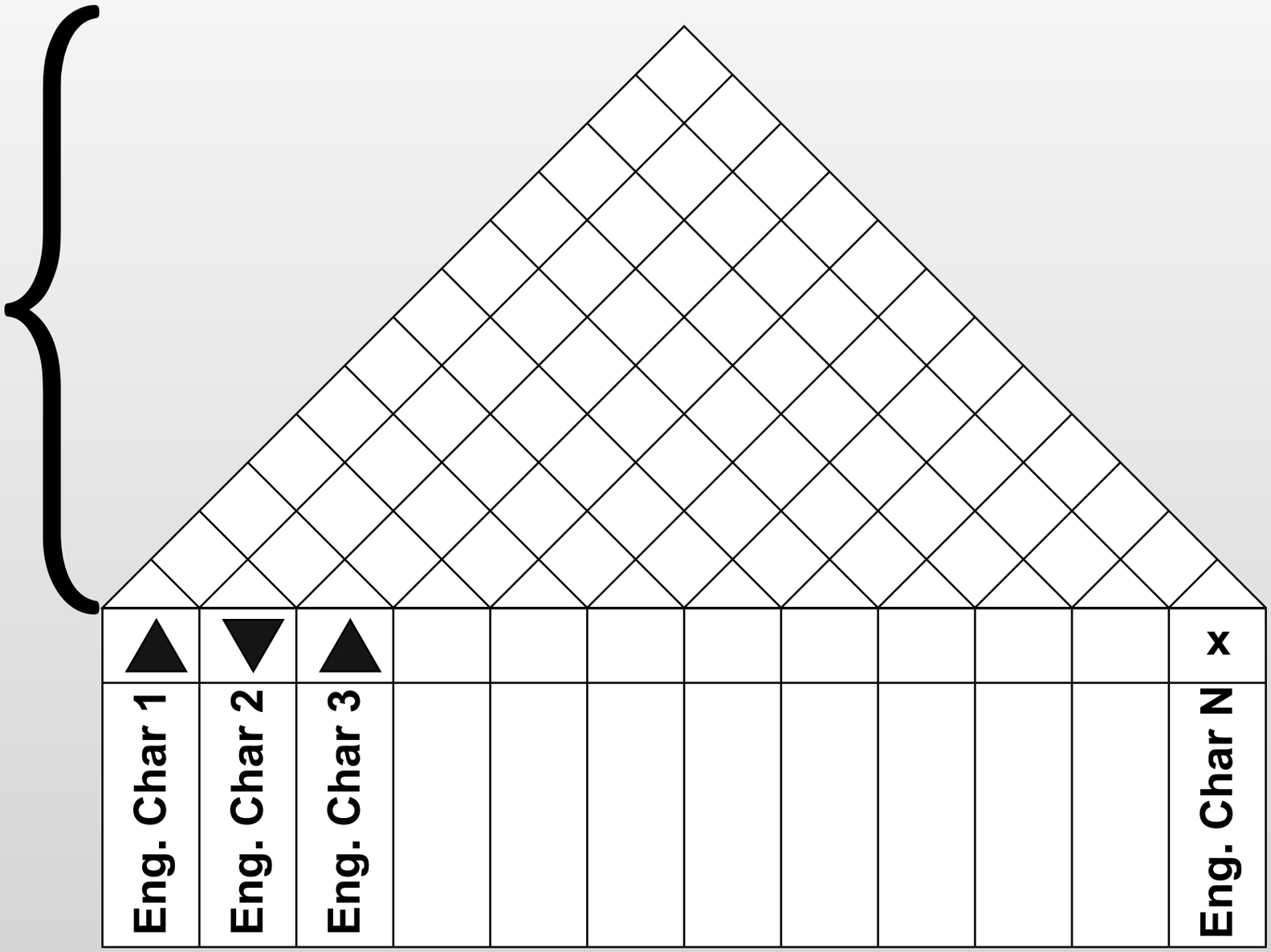


The HoQ Correlation Matrix

How do improvements toward the goal affect others?



The HoQ Correlation Matrix

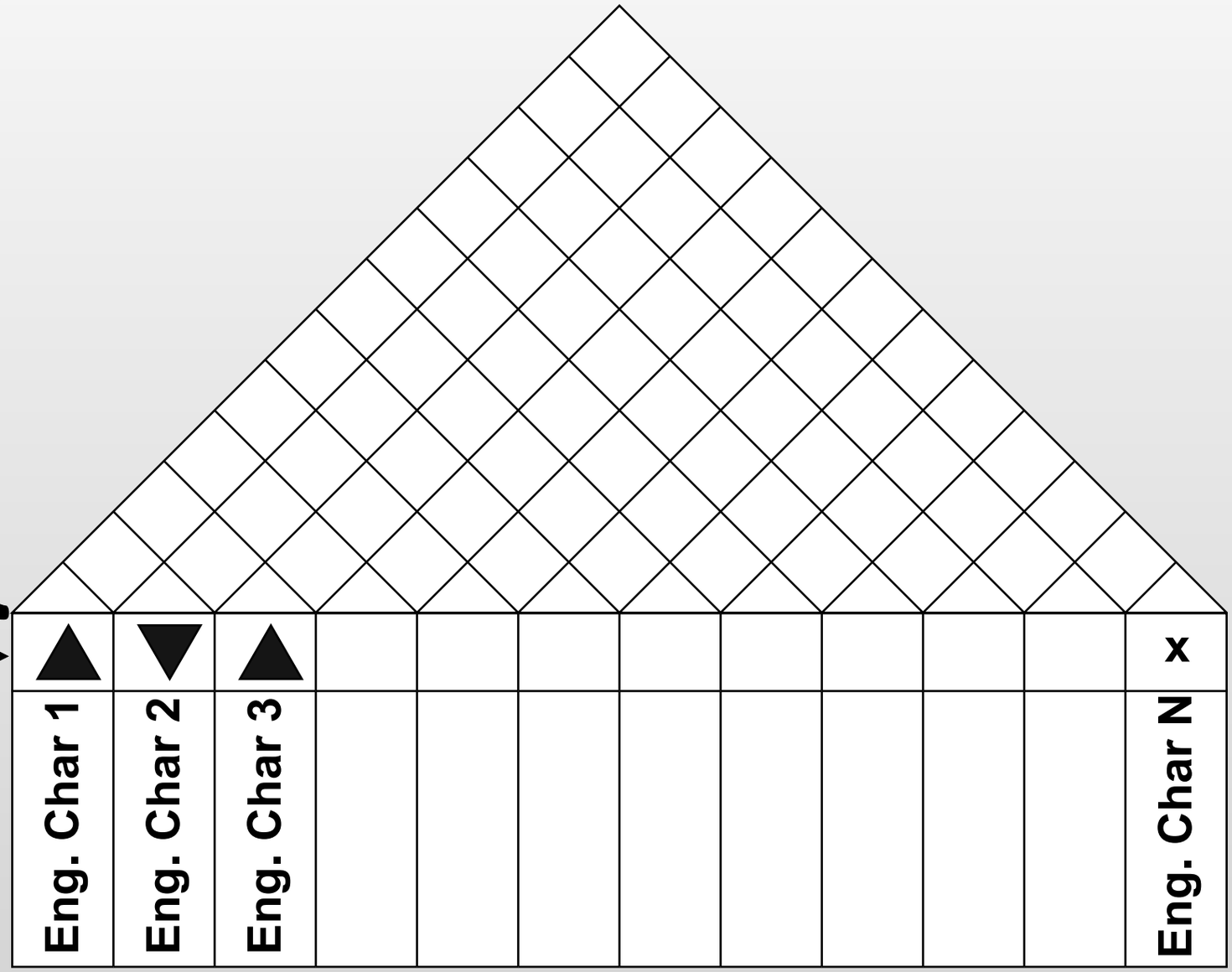
How do improvements toward the goal affect others?

Goal:

Maximize – ▲

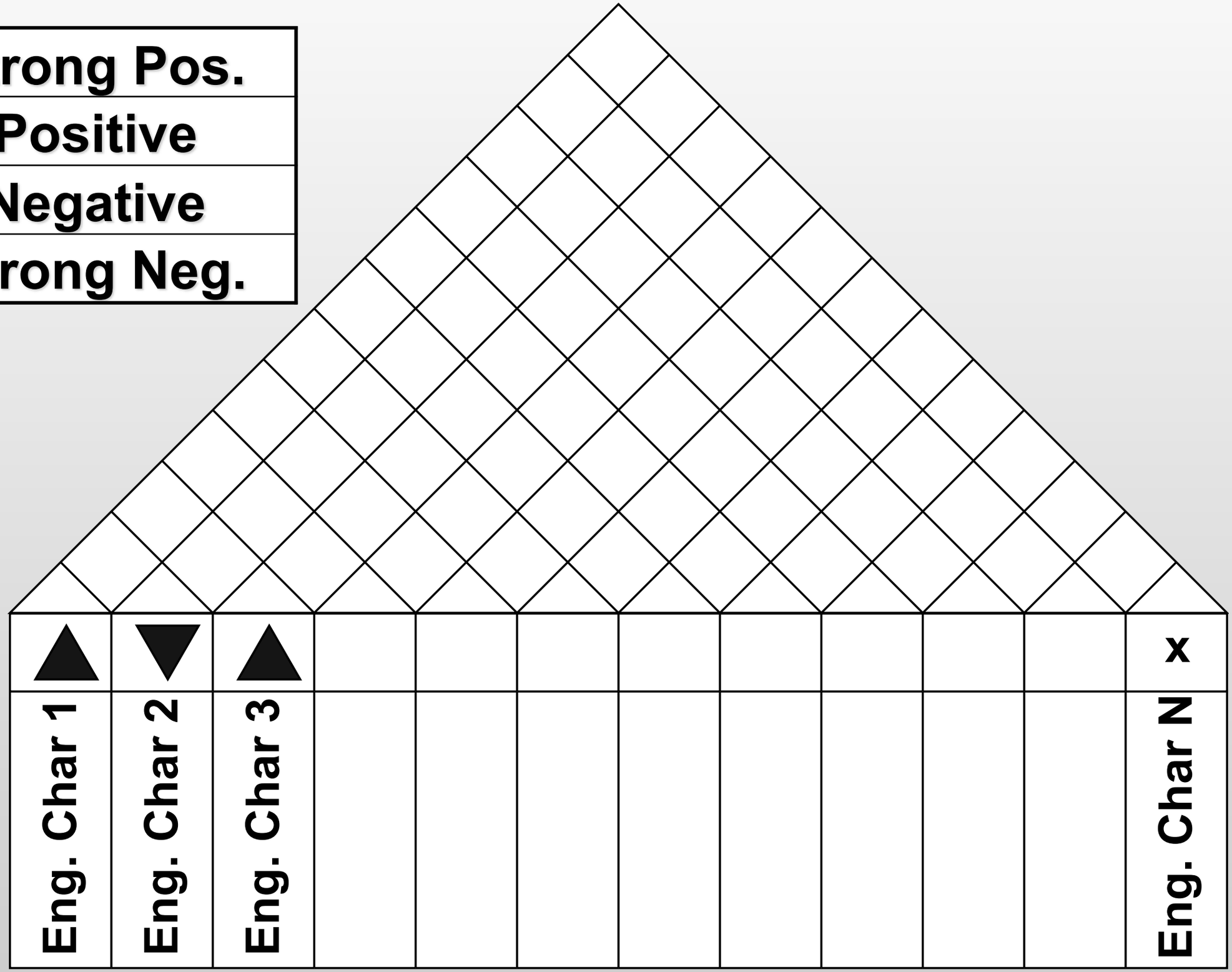
Minimize – ▼

Meet Target – x



The HoQ Correlation Matrix

++	Strong Pos.
+	Positive
-	Negative
- -	Strong Neg.



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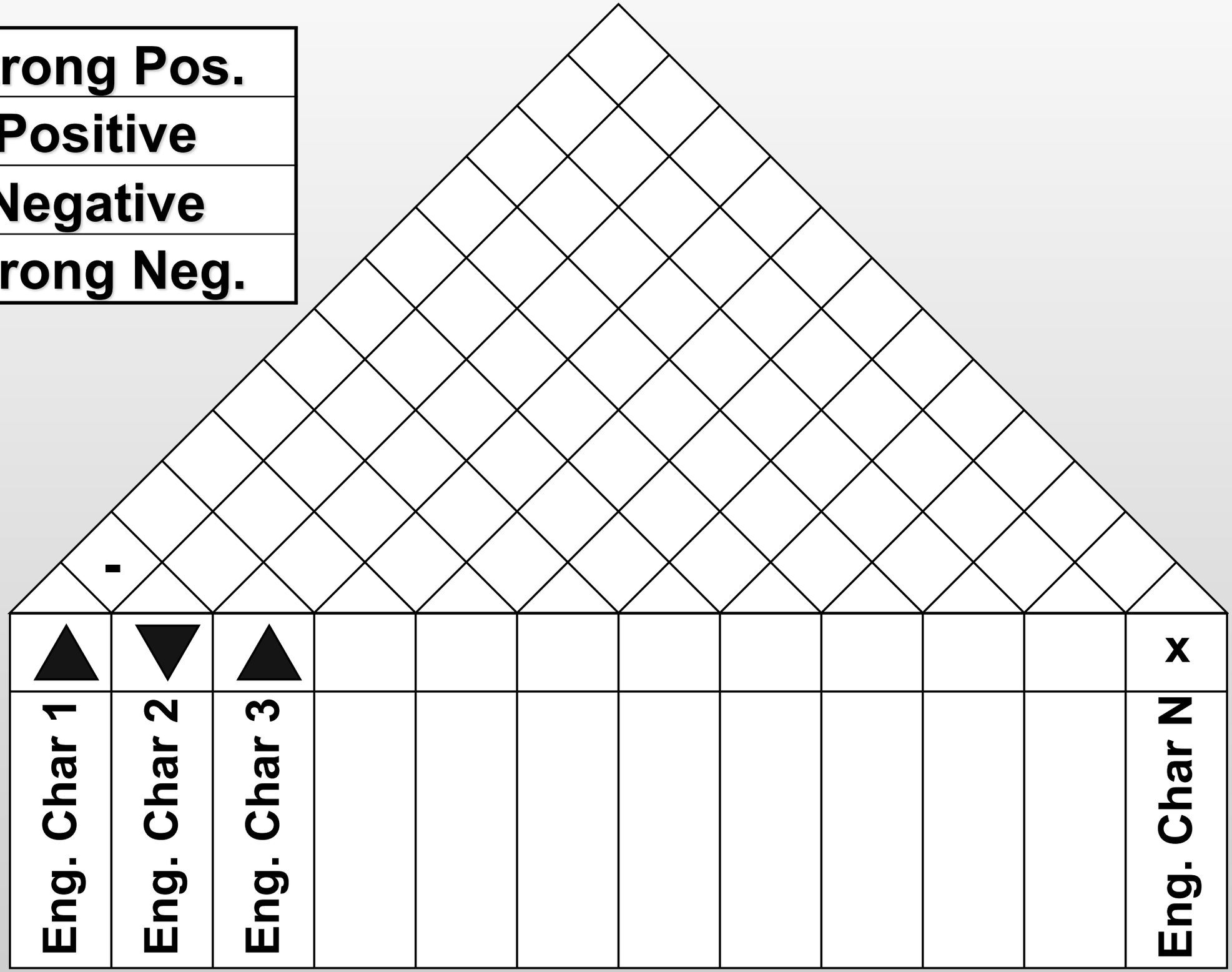

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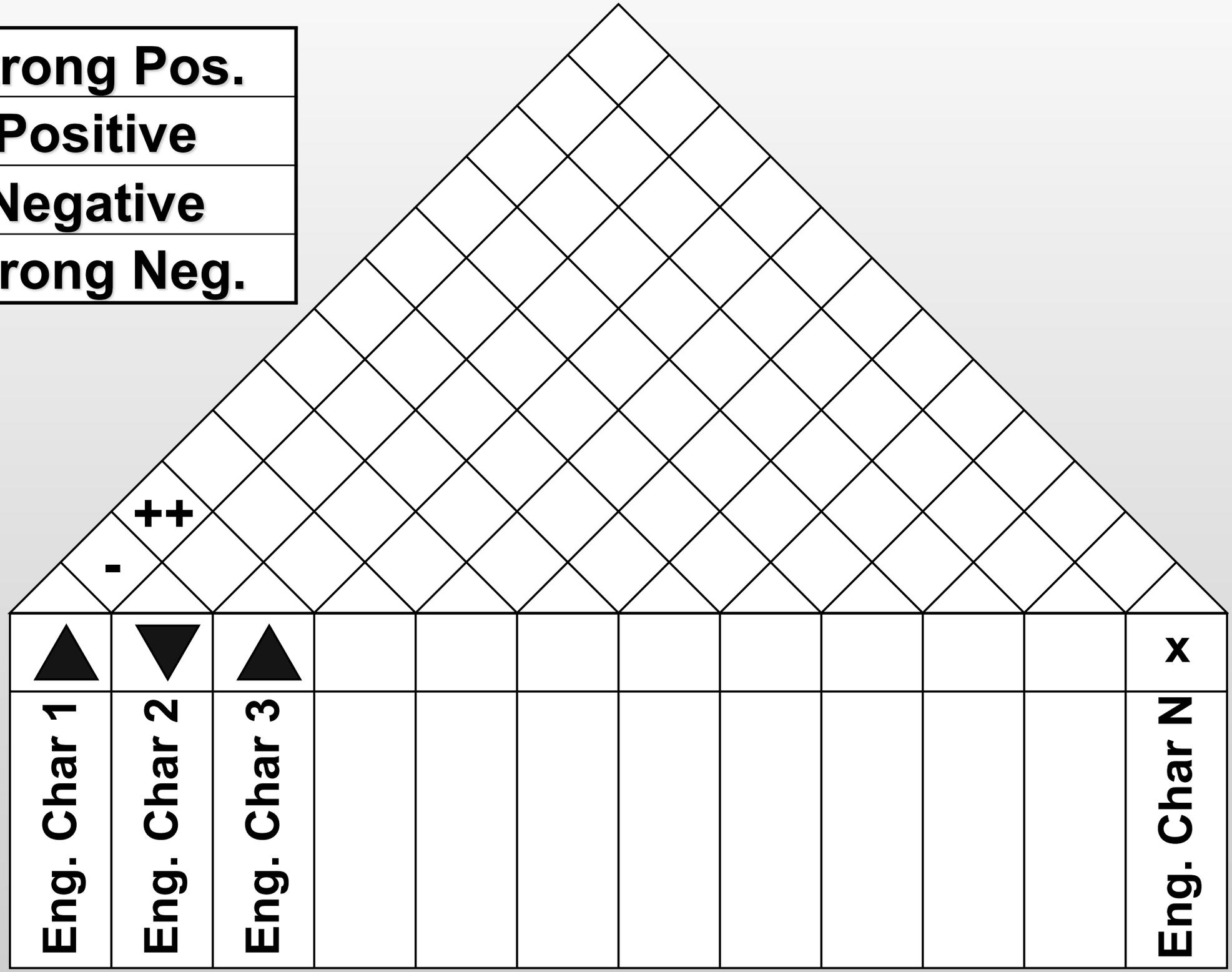

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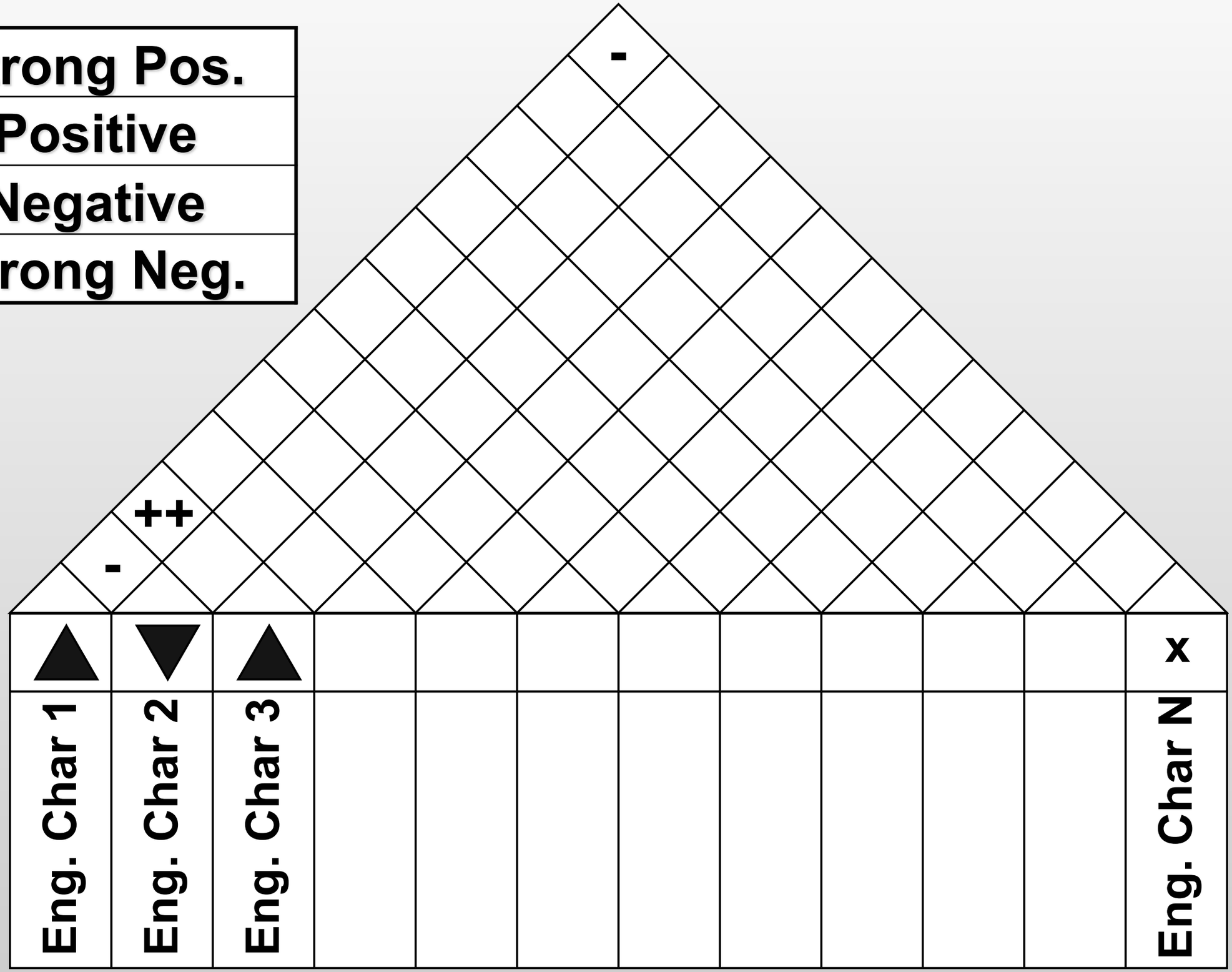

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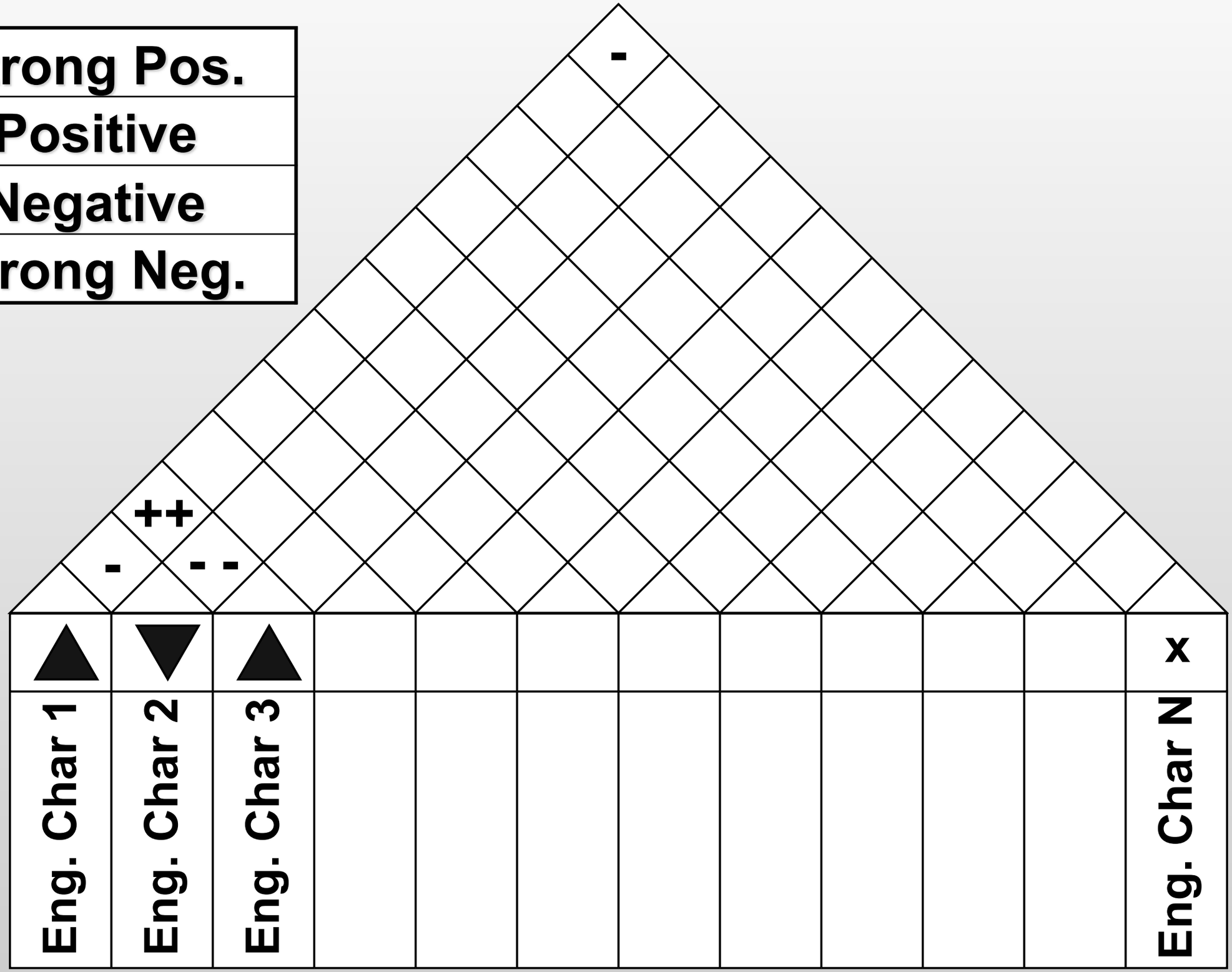

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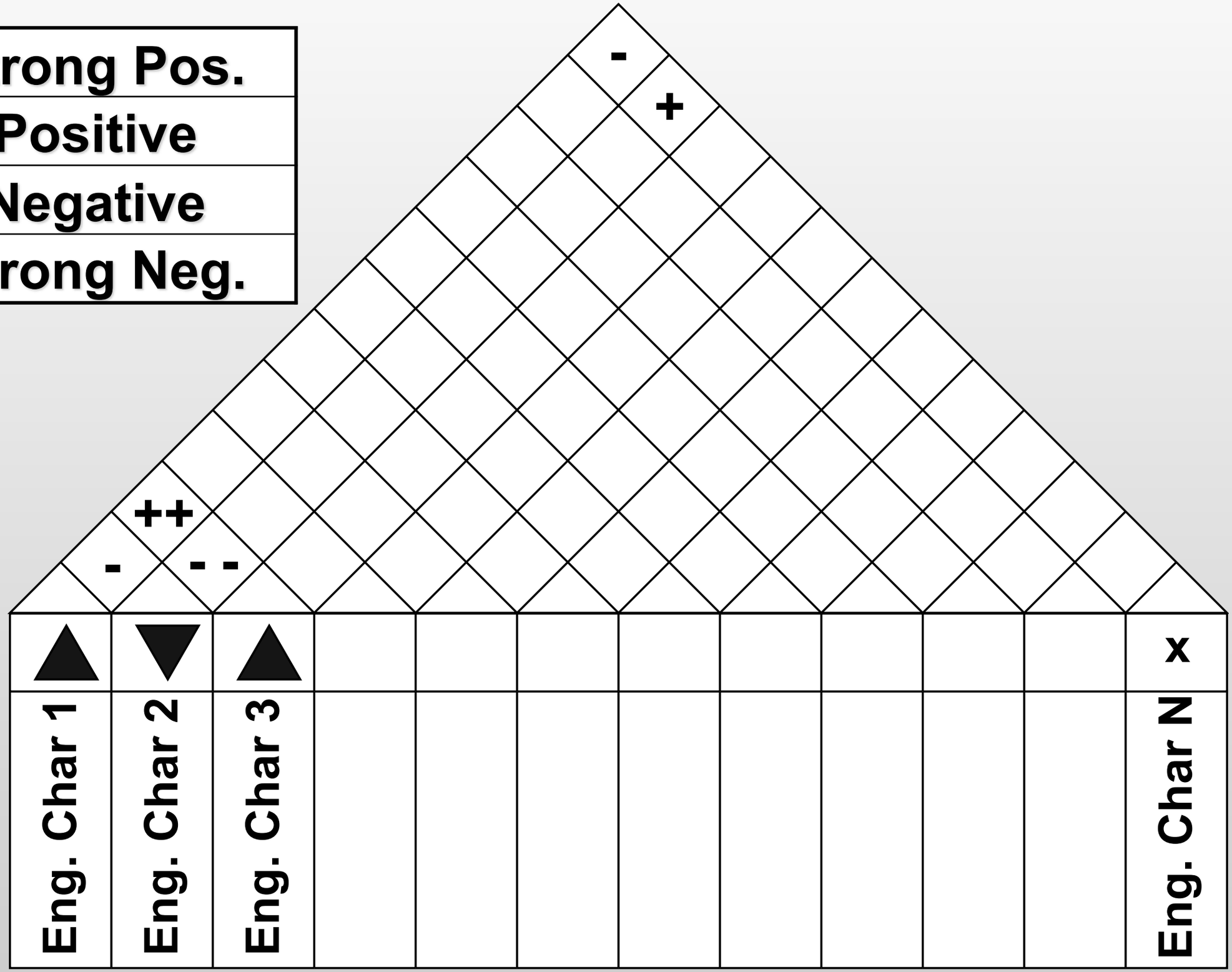

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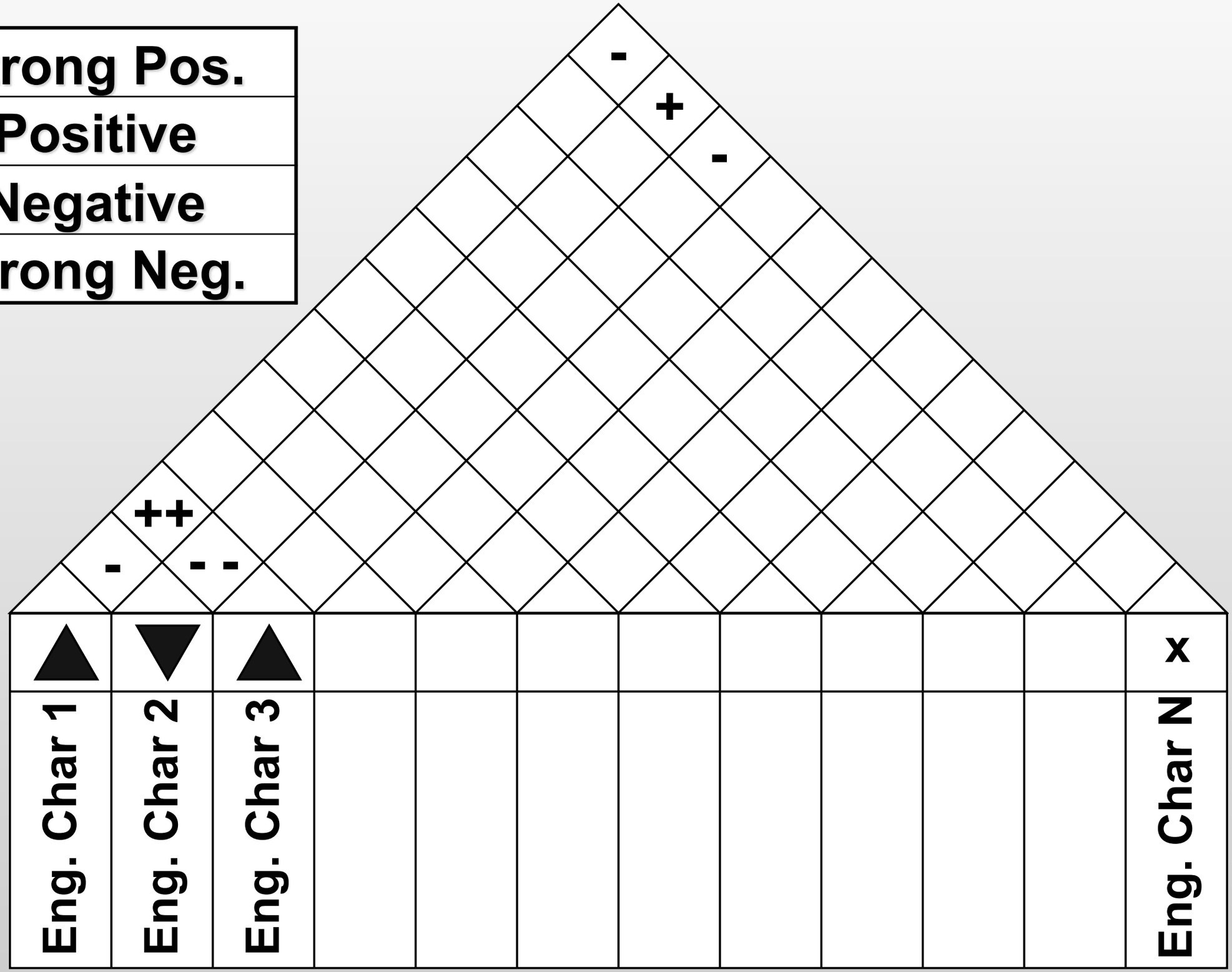

Design Specifications

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  - Customer requirements

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- **Numerical targets** that ***all*** possible concepts must meet

- Derived from:
  - Standards
  - Customer requirements
  - Engineering Analysis

The Spec. Sheet

		For: **PRODUCT NAME**	**Issued:** mm/dd/yy	
			Page x of N	
Changes	**D/W**	**Requirements**	**Resp.**	**Source**

The Spec. Sheet

		For: **PRODUCT NAME**	**Issued:** mm/dd/yy	
			Page x of N	
Changes	**D/W**	**Requirements**	**Resp.**	**Source**

Requirements, sorted by category.

The Spec. Sheet

		For: **PRODUCT NAME**	**Issued:** mm/dd/yy	
			Page x of N	
Changes	**D/W**	**Requirements**	**Resp.**	**Source**
	Demand or Wish?	**Requirements, sorted by category.**		

The Spec. Sheet

		For: **PRODUCT NAME**	**Issued:** mm/dd/yy	
			Page x of N	
Changes	**D/W**	**Requirements**	**Resp.**	**Source**
	Demand or Wish?	**Requirements, sorted by category.**		**What is the source of this requirement?**

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		For: **PRODUCT NAME**	**Issued:** mm/dd/yy	
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Changes	**D/W**	**Requirements**	**Resp.**	**Source**
	Demand or Wish?	**Requirements, sorted by category.**	**Who is responsible?**	**What is the source of this requirement?**

The Spec. Sheet

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			Page x of N	
Changes	**D/W**	**Requirements**	**Resp.**	**Source**
Date of last change.	**Demand or Wish?**	**Requirements, sorted by category.**	**Who is responsible?**	**What is the source of this requirement?**

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- Break large, difficult design process into many small easy ones

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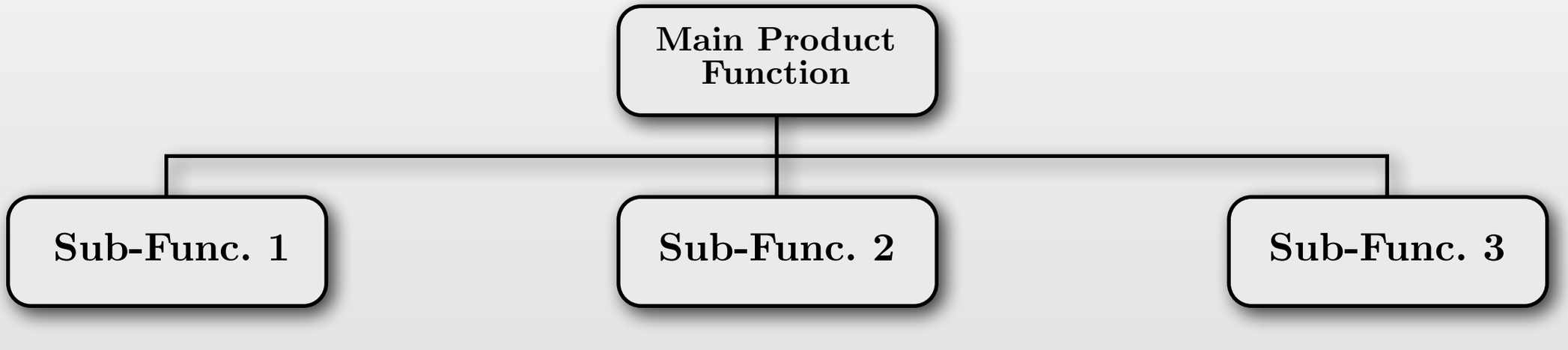

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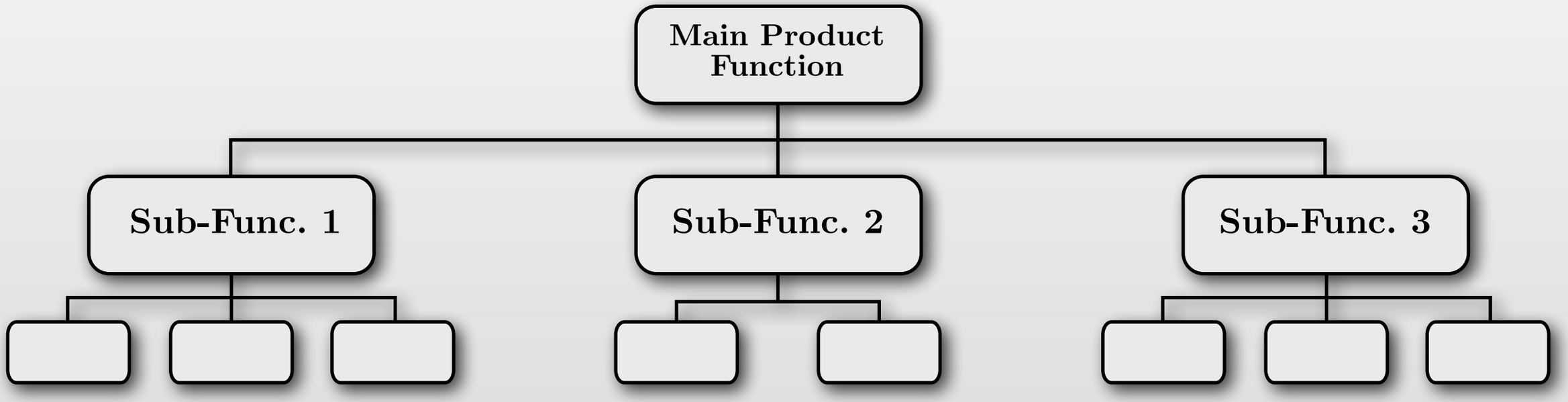

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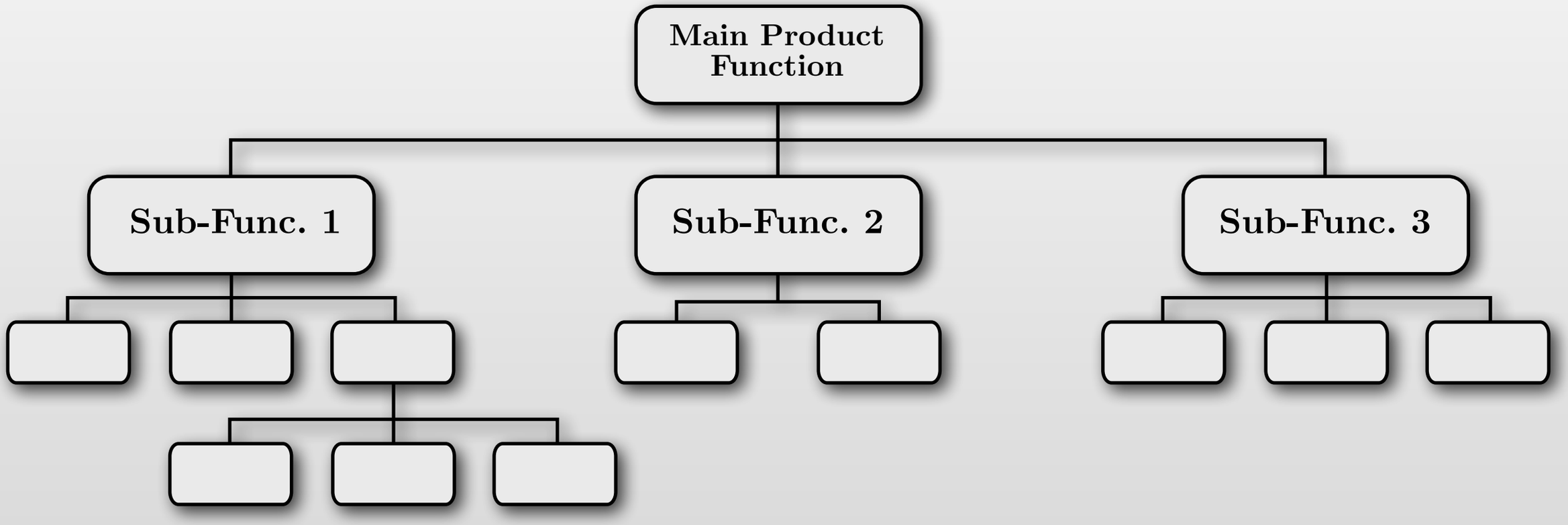

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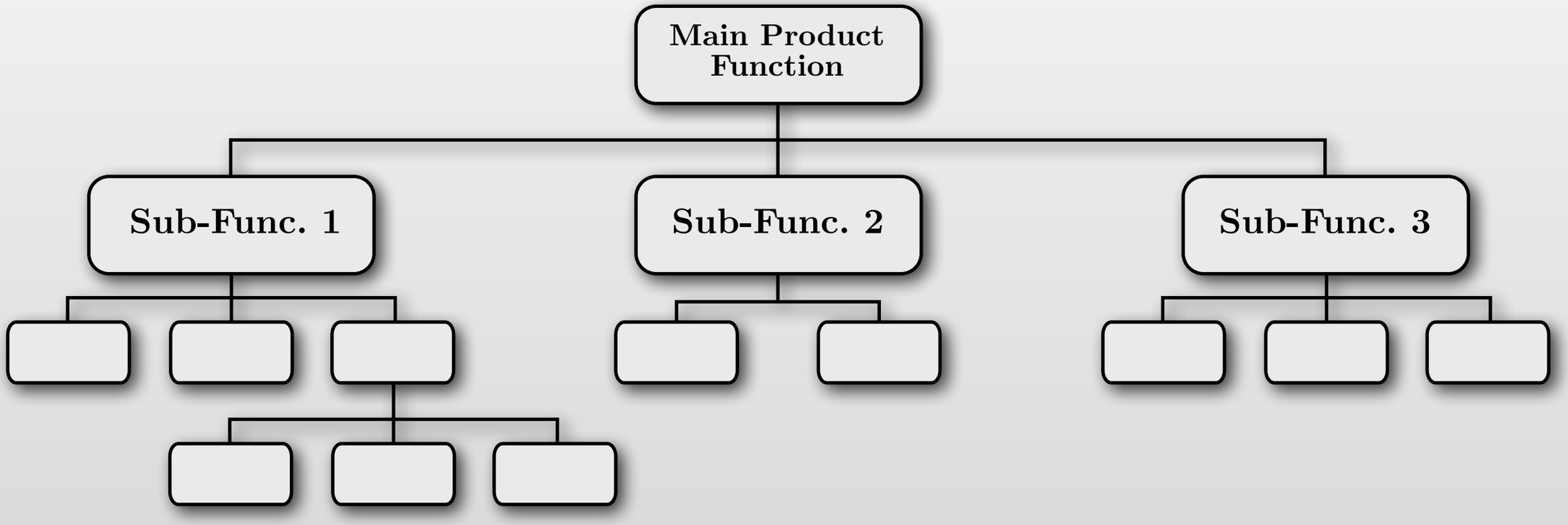

- Continue until the sub-functions are almost trivial

Function Trees (cont.)

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- Functions are *NOT*
  - Specific solutions – *e.g.* "Move arm 180 deg."

Function Trees (cont.)

- Functions are actions the concept is capable of *doing*

- Function Tree levels represent complexity not time ordering (It's not a flow chart.)

- Functions are *NOT*
  - Specific solutions – *e.g.* "Move arm 180 deg."
  - Constraints or specs – *e.g.* "Be smaller than..."

Morphological Charts

	Idea 1	Idea 2	Idea 3	…	…	…	…
Sub func 1							
Sub func 2							
Sub func 3							
…							
…							
…							

Morphological Charts

	Idea 1	Idea 2	Idea 3	…	…	…	…
Sub func 1							
Sub func 2							
Sub func 3							
…							
…							
…							

Each cell is a sketch.

Simple representation of the idea.

Allows for quick, visual comparisons.

Morphological Charts

	Idea 1	Idea 2	Idea 3	…	…	…	…
Sub func 1							
Sub func 2							
Sub func 3							
…							
…							
…							

Morphological Charts

	Idea 1	Idea 2	Idea 3	…	…	…	…
Sub func 1							
Sub func 2							
Sub func 3							
…							
…							
…							

Design 1

Morphological Charts

	Idea 1	Idea 2	Idea 3	…	…	…	…
Sub func 1							
Sub func 2							
Sub func 3							
…							
…							
…							

Design 1

Design 2

The Problem Understanding Form

◉	Strong = 9
▣	Medium = 3
△	Weak = 1

		Engineering Characteristics				
Customer Requirements	5	◉		▣	△	
	6		◉	▣		▣
	9	◉	▣		△	
	2	▣	△			▣
	1		◉	△	◉	△
Absolute Importance		132	92	34	23	73
Relative Importance		0.37	0.26	0.1	0.06	0.21

The Problem Understanding Form

◉	Strong = 9
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Customer Requirements		Engineering Characteristics				
	5	◉		▣	△	
	6		◉	▣		▣
	9	◉	▣		△	
	2	▣	△			▣
	1		◉	△	◉	△
Absolute Importance		132	92	34	23	73
Relative Importance		0.37	0.26	0.1	0.06	0.21

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**					
	6					
	9					
	2					
	1					

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**					
	6					
	9					
	2					
	1					

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**					
	6					
	9					
	2					
	1					

3rd-Level Evaluation Matrix

Customer Requirements						
	5					
	6					
	9					
	2					
	1					

3rd-Level Evaluation Matrix

Customer Requirements						
	5	7				
	6					
	9					
	2					
	1					

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**	**7**	**6**	**9**	**5**	**4**
	6	**0**	**7**	**10**	**5**	**2**
	9	**3**	**2**	**3**	**10**	**8**
	2	**5**	**6**	**5**	**8**	**0**
	1	**6**	**9**	**2**	**0**	**3**

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**	**7**	**6**	**9**	**5**	**4**
	6	**0**	**7**	**10**	**5**	**2**
	9	**3**	**2**	**3**	**10**	**8**
	2	**5**	**6**	**5**	**8**	**0**
	1	**6**	**9**	**2**	**0**	**3**
Absolute Total						

Design “Scores”

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- Relative Total

$$\text{Relative Total} = \frac{\text{Absolute Total}}{\text{Max. Possible}}$$

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**	**7**	**6**	**9**	**5**	**4**
	6	**0**	**7**	**10**	**5**	**2**
	9	**3**	**2**	**3**	**10**	**8**
	2	**5**	**6**	**5**	**8**	**0**
	1	**6**	**9**	**2**	**0**	**3**
Absolute Total		**78**	**111**	**134**	**161**	**107**

3rd-Level Evaluation Matrix

						
Customer Requirements	**5**	**7**	**6**	**9**	**5**	**4**
	6	**0**	**7**	**10**	**5**	**2**
	9	**3**	**2**	**3**	**10**	**8**
	2	**5**	**6**	**5**	**8**	**0**
	1	**6**	**9**	**2**	**0**	**3**
Absolute Total		**78**	**111**	**134**	**161**	**107**
Relative Total		**0.34**	**0.48**	**0.58**	**0.7**	**0.47**

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Phases of Design – Tools Used

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1. Problem Understanding

Phases of Design – Tools Used

1. Problem Understanding
    a. Problem Understanding Form

Phases of Design – Tools Used

1. Problem Understanding
    a. Problem Understanding Form
    b. House of Quality

Phases of Design – Tools Used

1. Problem Understanding
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2. Specification Development

Phases of Design – Tools Used

1. Problem Understanding
    a. Problem Understanding Form
    b. House of Quality

2. Specification Development
    a. Specification Sheet

Phases of Design – Tools Used

1. Problem Understanding
    a. Problem Understanding Form
    b. House of Quality

2. Specification Development
    a. Specification Sheet
    b. Function Tree

Phases of Design – Tools Used

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3. Conceptual Design

Phases of Design – Tools Used

1. Problem Understanding
    a. Problem Understanding Form
    b. House of Quality

2. Specification Development
    a. Specification Sheet
    b. Function Tree

3. Conceptual Design
    a. Morphological Chart

Phases of Design – Tools Used

1. Problem Understanding
    a. Problem Understanding Form
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2. Specification Development
    a. Specification Sheet
    b. Function Tree

3. Conceptual Design
    a. Morphological Chart
    b. Concept Evaluation

Phases of Design – Tools Used

1. Problem Understanding
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The entire process is iterative, including the tools!