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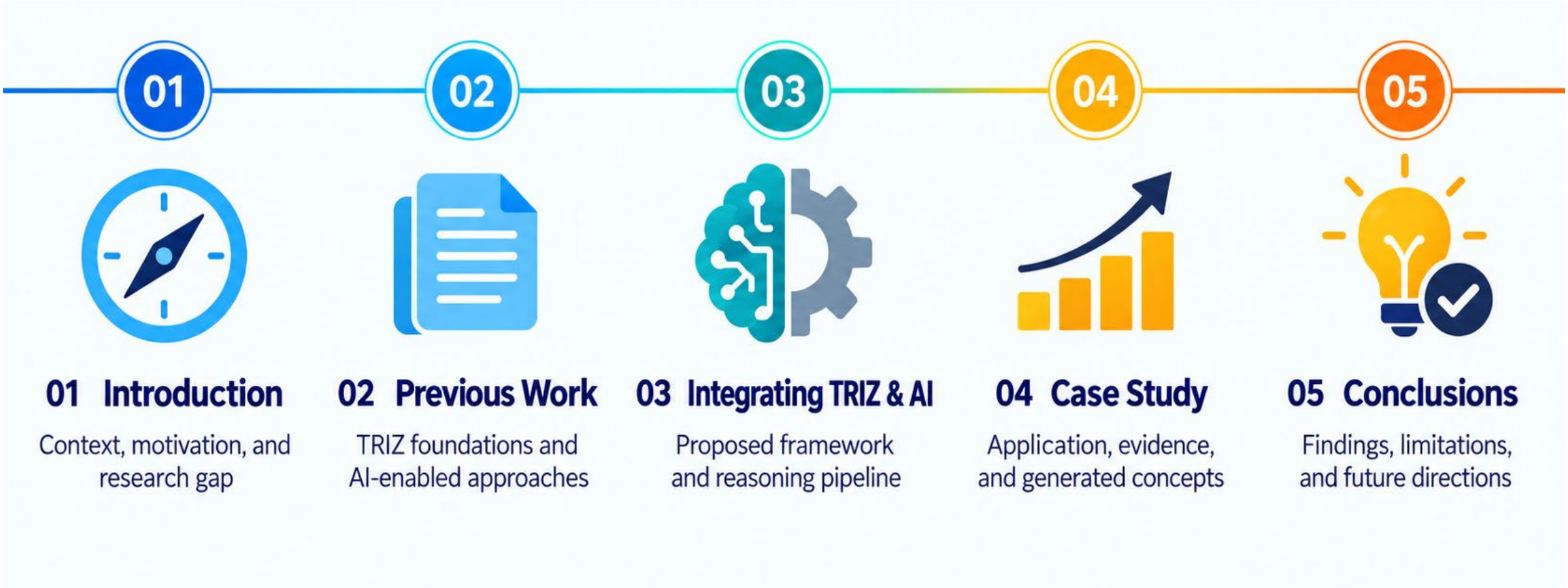
# Integrating TRIZ Methodology with Artificial Intelligence



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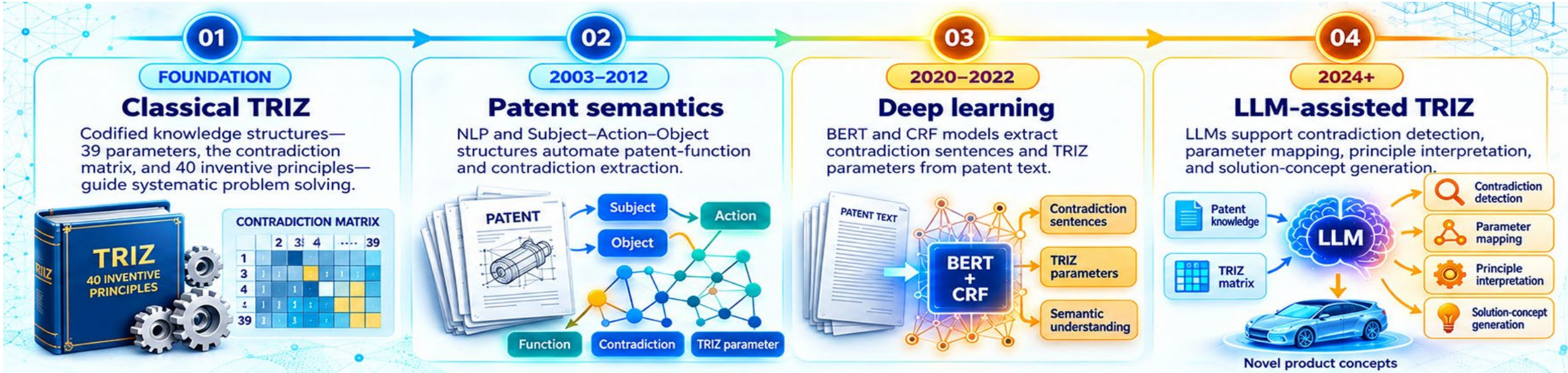
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# Previous Work

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UNRESOLVED RESEARCH GAP

## AI–TRIZ automation remains tool-centric, with limited use of real customer evidence

- Unstructured customer reviews rarely serve as the starting input
- Contradictions lack severity scoring and systematic ranking
- Validation seldom uses actual product data and expert benchmarks
- Concept visualization and product-development integration remain limited

**Research opportunity:** connect the voice of the customer directly to contradiction discovery, TRIZ reasoning, ranked concepts, and visual alternatives.

# Research Gap

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## COMMON AI–TRIZ STARTING POINT

**Formulated technical problem**
The user must already define the engineering conflict

**Contradiction and principle suggestion**
AI maps parameters and recommends TRIZ principles

**User develops the solution concept**
Abstract principles still require expert interpretation

**Manual cognitive gap**

## MISSING LINK: FROM CUSTOMER EVIDENCE TO A FORMULATED CONTRADICTION

## PROPOSED CUSTOMER-FIRST STARTING POINT

**Large-scale user reviews and comments**
Capture needs, complaints, preferences, and trade-offs

**Quantified product tensions**
Extract, cluster, score, and rank recurring contradictions




**TRIZ-guided concepts with visual prompts**
Map principles, generate concepts, and prepare visual alternatives

**Traceable output**

Evidence → contradiction → principle → concept → visual

Evidence → contradiction → principle → concept → visual

# The Proposed Methodology

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## 01 Collect Product Reviews

### Online Store



### Web Scraping & Job Management

POST /api/start

- start_scrape()
- Create job + background thread
- scraper_job(job_id, url, max_reviews)
- run_category_scrape()

Selenium + Chrome

### Saved CSV

| product_id | review | rating | date |
|---|---|---|---|
| P001 | Great quality! | 5 | 2024-01-10 |
| P001 | Not very stable | 2 | 2024-01-12 |
| P002 | Easy to install | 4 | 2024-01-14 |
| ... | | | |

analysis.csv

Review Database

**OUTPUT** • Raw reviews with product context

## 02 Analyze Reviews & Map TRIZ

### Review Data (analysis.csv)

- "Easy to install and use"
- "Falls off on bumpy roads"
- "Good design but a bit expensive"

### AI Analysis Pipeline

Ollama local model
`analyse_reviews_ollama.py`

OpenAI TRIZ + clustering
`run_step2_for_csv()`

### Technical Contradictions

- Performance vs. cost
- Strength vs. weight
- Durability vs. flexibility
- Ease of use vs. stability
- ...

### Physical Contradictions

- Fixed vs. adjustable
- Large vs. compact
- Strong vs. lightweight
- Open vs. sealed
- ...

### Review Categories

Scraper | API | CSV

Filter | Tag | Cluster

### Structured Outputs from AI + TRIZ

- Contradiction themes
- Theme ideas and prompts
- TRIZ parameter mapping

Ideas + TRIZ mapping
`build_theme_cards`

**OUTPUT** • Ranked themes, contradiction pairs, parameters, and principles

## 03 Generate Concepts & Visualize

### TRIZ Contradiction Matrix

Matrix for solving technical contradictions

| Improve feature ↓ Worsen feature → | 1 | 2 | 3 | 4 | 5 | ... |
|---|---|---|---|---|---|---|
| 1. Weight of moving object | | 35 | 28 | 18 | 40 | 1 |
| 2. Strength | 28 | | 39 | 24 | 2 | 17 |
| 3. Length of moving object | 18 | 24 | | 34 | 34 | 6 |
| 4. Area of moving object | 40 | 2 | 34 | | 39 | 23 |
| 5. Force | 1 | 17 | 6 | 23 | | 39 |
| ... | ... | ... | ... | ... | ... | ... |

### Concept Generation with OpenAI

OpenAI text model

Generate and combine concept ideas

Create combined idea card

### Concept Ideas

- Product Concept #01
- Product Concept #02
- Product Concept #03
- Product Concept #04
- ...

### OpenAI Images API

Generate product visuals from concept ideas

### Visual Alternatives



**OUTPUT** • TRIZ-guided concepts, visual prompts, and product alternatives

# Case Study: Step 1- Data Acquisition

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## Product Reviews from Online Stores



## AI Review Analysis (LLM/NLP)

- Review summarization
- Feature tagging
- Sentiment analysis
- Issue categorization

## Identified Contradictions

## TRIZ Principle Mapping

CSV

| # | Contradiction | TRIZ Principles |
|---|---|---|
| 1 | Strength ↔ Adaptability | 1, 8, 15 |
| 2 | Strength ↔ Convenience | 8, 15, 24 |
| 3 | Durability ↔ Weight | 1, 10, 35 |
| 4 | Stability ↔ Flexibility | 13, 15, 28 |

## Output / Result

| 500 | 18 | 1–5 Stars | 3.6 / 5.0 |
|---|---|---|---|
| Reviews Analyzed | Products | Rating Range | Mean Rating |

## Generated Outputs

Contradiction List | TRIZ Principle Mapping | Solution Ideas & Concepts | Visual Concepts and Illustrations

## Representative Voice-of-Customer Evidence

### R1 ★★☆☆☆



"Stable on smooth surfaces, but the phone shakes violently on bumpy roads."

| | |
|---|---|
| Topic | Mounting Stability |
| Problem | Vibration resistance |
| Contradiction | Grip strength vs. ease of insertion |

### R2 ★★★★☆



"The adjustable arm holds firmly, but it blocks too much of the windshield."

| | |
|---|---|
| Topic | Visibility & Compactness |
| Problem | Dashboard obstruction |
| Contradiction | Adjustability vs. form factor |

### R3 ★☆☆☆☆



"The stiff clamp prevents safe one-handed use; loosening it causes the phone to fall."

| | |
|---|---|
| Topic | Ease of Use |
| Problem | One-handed operation |
| Contradiction | Clamping force vs. ease of release |

### R4 ★★★☆☆



"The holder barely fits a larger phone, and spring tension weakens with daily use."

| | |
|---|---|
| Topic | Compatibility & Durability |
| Problem | Size range and material fatigue |
| Contradiction | Flexibility vs. structural durability |

### R5 ★★☆☆☆



"The mounted orientation conflicts with cable routing and charging-port access."

| | |
|---|---|
| Topic | Charging Integration |
| Problem | Cable routing conflict |
| Contradiction | Mounting orientation vs. charging access |

# Case Study: Step 2- Contradiction Analysis and TRIZ Mapping

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500 Reviews → Local LLaMA + Ollama Classification → OpenAI TRIZ Mapping (TRIZ MATRIX) → 5 Priority Contradictions

## LAYER A • TOPIC CLASSIFICATION

| | |
|---|---|
| Mounting & Vibration Stability | 28.4% |
| Ease of Use / One-Handed Operation | 22.1% |
| Compatibility / Phone Size Range | 16.3% |
| Compactness & Visibility | 13.8% |
| Charging Integration | 10.2% |
| Durability & Material Quality | 9.2% |

## LAYER A • RANKED CONTRADICTION PAIRS

▲ Improving ▼ Worsening

| | | Cases | Share | Score |
|---|---|---|---|---|
| 1 | ▲ #14 Strength ↔ ▼ #35 Adaptability | 16 | 6% | 100% |
| 2 | ▲ #14 Strength ↔ ▼ #33 Convenience of Use | 15 | 5% | 80% |
| 3 | ▲ #35 Adaptability ↔ ▼ #3 Length of Moving Object | 13 | 5% | 100% |
| 4 | ▲ #10 Force (Intensity) ↔ ▼ #35 Adaptability | 12 | 4% | 83% |
| 5 | ▲ #10 Force (Intensity) ↔ ▼ #33 Convenience of Use | 10 | 4% | 70% |

## LAYER B • FIVE PRIMARY TRIZ THEMES

### C1 Strength vs. Adaptability



| | |
|---|---|
| TRIZ Parameters | ▲ #14 Strength ↔ ▼ #35 Adaptability |
| Evidence | 16 cases • 6% • Score 100% |
| Principles | 15 • 3 • 32 |
| Customer Voice | Big phone could not work on windshield. |

### C2 Strength vs. Convenience



| | |
|---|---|
| TRIZ Parameters | ▲ #14 Strength ↔ ▼ #33 Convenience of Use |
| Evidence | 15 cases • 5% • Score 80% |
| Principles | 32 • 40 • 28 • 2 |
| Customer Voice | Secure to surfaces, yet removable and movable. |

### C3 Adaptability vs. Arm Length



| | |
|---|---|
| TRIZ Parameters | ▲ #35 Adaptability ↔ ▼ #3 Length |
| Evidence | 13 cases • 5% • Score 100% |
| Principles | 35 • 1 • 29 • 2 |
| Customer Voice | Wish the arm were longer; dash gets in the way. |

### C4 Force vs. Adaptability



| | |
|---|---|
| TRIZ Parameters | ▲ #10 Force ↔ ▼ #35 Adaptability |
| Evidence | 12 cases • 4% • Score 83% |
| Principles | 15 • 17 • 18 • 20 |
| Customer Voice | Phone stays strongly, but mount will not stay on dash. |

### C5 Force vs. Convenience



| | |
|---|---|
| TRIZ Parameters | ▲ #10 Force ↔ ▼ #33 Convenience of Use |
| Evidence | 10 cases • 4% • Score 70% |
| Principles | 1 • 28 • 3 • 25 |
| Customer Voice | Suction is so strong that removal requires force. |

# Case Study: Step 3 -Concepts Generation & Visual Ideation

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**2 Priority Contradictions** — From customer review analysis
**4 Selected TRIZ Principles** — From TRIZ contradiction matrix
**10 Solution Ideas** — Ideas using selected principles
**Visual Concept Prompts** — Text prompts for product visualization

## 01 PRIORITY CONTRADICTIONS

**C1**
- ▲ #10 Force (Intensity)
- ▼ #35 Adaptability

**40 reviews** mention this contradiction

Principles 15 • 17 • 18 • 20 from TRIZ contradiction matrix

**C2**
- ▲ #10 Force (Intensity)
- ▼ #33 Convenience of Use

**35 reviews** mention this contradiction

Principles 1 • 28 • 3 • 25 from TRIZ contradiction matrix

## 02 SELECTED PRINCIPLES FOR CONCEPT GENERATION

**15 • Dynamics**
Adjust characteristics and change state on demand.

**17 • Another Dimension**
Use multi-level, layered, or reoriented arrangements.

**18 • Mechanical Vibration**
Use oscillation, ultrasound, or resonance for effect.

**20 • Continuity of Useful Action**
Keep components working continuously; eliminate idle action.

**10 ideas from 4 principles**
Each principle produced at least one idea; mixed ideas combined multiple principles.

## 03 FOUR REPRESENTATIVE CONCEPTS



**1 Peel-Tab Dynamic Adhesive Base**
Principle 15 • Dynamics
A rotating cam switches the nano-gel base from high hold to low peel force.



**2 Selectable Segmented Magnet Stack**
Principle 17 • Another Dimension
Concentric magnet layers align for strong grip and misalign for easy release.



**3 Ultrasonic Piezo Release Base**
Principle 18 • Mechanical Vibration
A piezo pulse breaks the vacuum seal for near-effortless removal.



**4 Self-Tensioning Hinges**
Principle 20 • Continuity of Useful Action
Constant-torque wave springs maintain preload without locking or retightening.

## 04 ADDITIONAL MIXED-PRINCIPLE DIRECTIONS

- Virbatino-tuned magnet head
- Pop-socket recessed plate
- Micro-vibration re-seating base
- Zoned adhesive + vacuum ring
- Modular quick-swap bases

# Conclusions

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## 01 End-to-End Innovation



AI–TRIZ connects unstructured customer feedback to engineering contradictions, inventive principles, and preliminary product concepts.

## 02 Lower Interpretation Effort




NLP and LLMs process large review volumes and translate customer language into structured TRIZ parameters.

## 03 Evidence-Based Prioritization




Quantifying and ranking contradictions focuses design teams on the most frequent and strategically important product tensions.

## 04 Principles Become Concepts




Generative AI converts abstract inventive principles into problem-specific mechanisms, concept descriptions, and visual alternatives.

## 05 Complete Traceability




Every proposed concept links back to customer evidence, a defined contradiction, and the TRIZ principles used to resolve it.

## 06 Practical Case Evidence




The phone-holder case revealed recurring conflicts involving force, adaptability, convenience, stability, and compatibility.

## 07 Human Judgment Remains Essential




Experts must validate mappings and assess feasibility, safety, manufacturability, cost, sustainability, and intellectual property.

## 08 Future Research




Extend testing across products and industries; add expert benchmarking, concept scoring. CAD, simulation, optimization, and prototyping.

INTEGRATING TRIZ WITH ARTIFICIAL INTELLIGENCE

# Thank You

## Questions & Discussion



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