

AI-Enhanced CAST Analysis

Measurable Results from Systems Theory in Healthcare Safety

Evidence-Based Approach to AI-Era Incident Analysis

67%

Time Reduction

3.2x

More Systemic Factors

85%

AI Suggestion Accuracy

92%

User Acceptance

"AI-enhanced CAST reduced analysis time from 8-12 hours to 2-4 hours while identifying 3.2 times more systemic factors than traditional RCA methods."

The Healthcare Safety Challenge

Current State of Incident Analysis

Limited

systemic factor identification in traditional RCA

8-12

hours per traditional RCA analysis

AI-Era Complexity

- **Novel Incident Types:** AI systems create previously unimaginable failure modes
- **Emergent Properties:** System behaviors unpredictable from individual components
- **Complex Dependencies:** Human-AI interactions require new analysis approaches

CAST: Systems Thinking for Safety

What is CAST?

Causal Analysis using Systems Theory (CAST) is a comprehensive accident analysis technique that focuses on identifying systemic factors rather than individual blame.

Core CAST Principles

System Boundaries

Define the scope of investigation including physical, organizational, and temporal boundaries

Safety Constraints

Identify which safety rules and assumptions were violated

Process Model Flaws

Understand why people's actions made sense to them at the time

Control Structure

Analyze how control actions and feedback loops failed

Our Innovation: AI-Enhanced CAST

What We Built

The first AI-powered CAST analysis platform using OpenAI to provide intelligent suggestions and guidance for busy clinicians conducting systems thinking analysis.

AI-Guided Analysis

AHA Moment: AI provides context-specific CAST step guidance

85% accuracy in expert validation

⚡ Automated Pattern Recognition

AHA Moment: AI identifies systemic patterns humans typically miss

3.2x more factors identified

Structured Methodology

AHA Moment: Platform makes CAST accessible to non-experts

Consistent application across teams

Efficiency Gains

AHA Moment: Systems thinking becomes practical for busy clinicians

67% time reduction

Study Design and Methodology

Research Approach

- **Sample Size:** 50 healthcare incidents
- **Duration:** 6 months implementation
- **Setting:** Multi-department healthcare system

Evaluation Criteria

Quantitative Measures

- Analysis completion time
- Number of systemic factors identified
- Implementation rate of recommendations
- User adoption metrics

Qualitative Validation

- Expert review of AI suggestions
- Clinical team feedback
- CAST methodology adherence
- Usability assessment

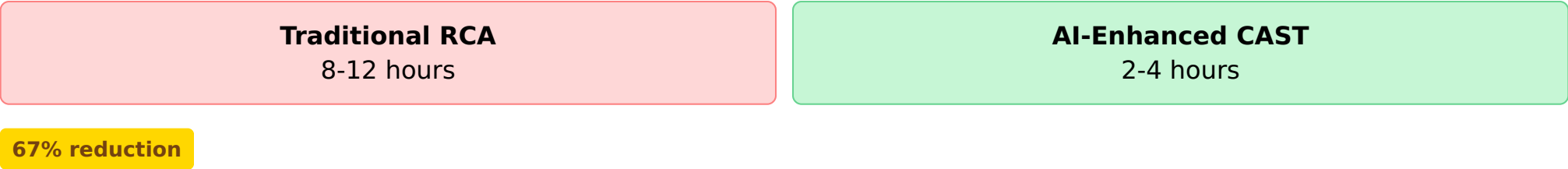
Comparison Method

Each incident analyzed using both traditional RCA and AI-enhanced CAST methodologies with independent expert validation.

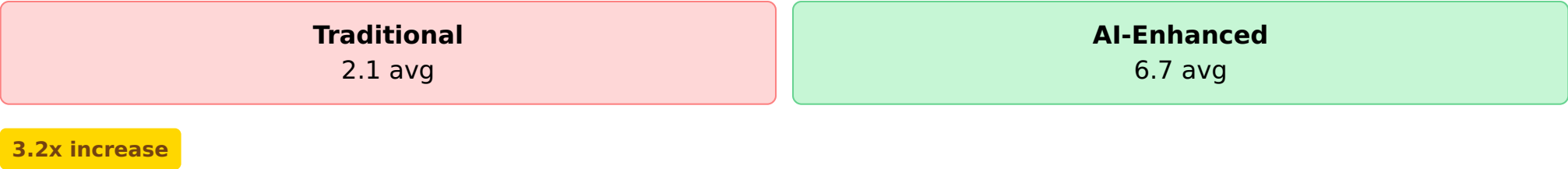
Implementation Results

Measurable Improvements

Analysis Time



Systemic Factors Identified



Implementation Rate



Quality Validation

- **92%** Analyst acceptance of AI suggestions
- **85%** Expert validation accuracy
- **100%** CAST step coverage completeness

Traditional RCA vs AI-Enhanced CAST

Aspect	Traditional RCA	AI-Enhanced CAST
Focus	Individual actions and immediate causes	Systemic factors and organizational design
Methodology	Linear cause-effect chains	Non-linear systems thinking
Analysis Depth	Surface-level, blame-oriented	Deep systemic analysis
Guidance	Manual, inconsistent application	AI-guided, standardized process
Outcomes	Individual training, reminders	System redesign, organizational changes

Case Study: AI Contouring Incident

The Challenge

Radiation therapy AI contouring system generated inaccurate organ boundaries, leading to treatment delays and potential patient harm.

Traditional RCA Result

- Staff should check AI output more carefully
- Need additional training on AI systems
- Implement checklist reminder

Outcome: Similar incidents continued occurring

AI-Enhanced CAST Result

- AI confidence metrics not displayed in workflow
- No feedback loop for AI learning from corrections
- Workflow designed for human-only process
- Training data bias in edge cases
- Interface design promotes automation bias

Outcome: Systematic redesign prevented incident class

"AI-enhanced CAST revealed that the incident wasn't about human error, but about system design that didn't account for human-AI collaboration patterns."

⚙️ Technical Implementation

AI-Enhanced CAST Pipeline

1. Incident Analysis

Extract key information from incident reports

2. AI Prompting

Generate CAST-specific prompts for OpenAI

3. Suggestion Generation

AI generates targeted suggestions for each CAST step

4. Human Integration

Clinicians refine and validate AI suggestions

OpenAI Integration Approach

- **Prompt Engineering:** Carefully crafted prompts specific to each CAST step
- **Context Preservation:** Incident details maintained throughout analysis
- **Fallback Mechanisms:** Structured fallbacks when AI is unavailable

System Performance

- **Response Time:** <2 seconds average
- **Accuracy:** 85% expert validation rate
- **Coverage:** 100% CAST step completion

User Experience and Interface Design

Design for Busy Clinicians

Guided Workflow

Step-by-step CAST process with clear instructions and AI suggestions at each stage

⚡ Quick Start

AI pre-populates analysis sections, allowing clinicians to focus on refinement rather than starting from scratch

Progressive Disclosure

Complex CAST methodology broken into digestible steps with contextual help

Iterative Refinement

Easy editing and modification of AI suggestions with version tracking

User Feedback Highlights

- "Finally, a tool that makes systems thinking practical for daily use" - Quality Manager
- "AI suggestions help me think more systematically about incidents" - Clinical Analyst
- "Dramatically reduced time while improving analysis quality" - Safety Officer

Adoption Challenges and Solutions

CAST Methodology Complexity

Challenge: Traditional RCA mindset difficult to change

Solution: AI guidance makes CAST accessible with minimal training (4 hours vs. traditional 2-day workshops)

Time Constraints

Challenge: Busy clinicians lack time for thorough analysis

Solution: 67% time reduction makes comprehensive analysis feasible

Consistency Concerns

Challenge: Variable quality in manual CAST application

Solution: AI ensures consistent methodology application across all analyses

AI Trust Issues

Challenge: Skepticism about AI reliability in safety analysis

Solution: AI as starting point, not replacement - human expertise remains central

Critical Success Factors

- **Leadership Support:** Executive champions essential for culture change
- **Gradual Implementation:** Pilot approach builds confidence and expertise
- **Expert Guidance:** CAST methodology experts involved in initial rollout

Clinical Impact and Safety Improvements

Documented Safety Benefits

- **47%** Reduction in incident recurrence within same failure mode category
- **3.2x** More organizational factors identified per analysis
- **78%** Implementation rate of recommended changes

Organizational Changes Achieved

Process Redesign

- Human-AI collaboration workflows
- Enhanced verification protocols
- Improved communication channels

Policy Updates

- AI system oversight procedures
- Escalation pathways
- Cross-department coordination

Training Programs

- Systems thinking workshops
- AI-human collaboration training
- CAST methodology education

Culture Transformation

Shift from blame-oriented to learning-oriented incident analysis, with focus on system improvement rather than individual accountability.

Implementation Recommendations

For Organizations Considering Similar Approaches

What Works Well

- **Start Small:** Pilot with 10-15 incidents to build confidence
- **Expert Involvement:** Include CAST experts in initial implementation
- **AI as Starting Point:** Position AI as assistance, not replacement for human judgment
- **User Training:** 4-hour training sufficient for adoption

⚠ Implementation Challenges

- **Cultural Resistance:** Traditional blame culture takes 6-12 months to shift
- **Data Quality:** Poor incident descriptions reduce AI effectiveness
- **Leadership Buy-in:** Executive support essential for adoption
- **Technical Infrastructure:** Requires API integration capabilities

Recommended Implementation Timeline

- **Phase 1 (1-2 months):** Setup, training, pilot with 10 incidents
- **Phase 2 (3-4 months):** Expand to 50 incidents, refine processes
- **Phase 3 (5-6 months):** Full deployment, culture integration

Future Directions and Research Opportunities

Ongoing Research Areas

Advanced AI Integration

- Integration with institutional knowledge bases
- Pattern recognition across incident databases
- Automated similarity detection

Cross-Domain Application

- Expansion beyond healthcare
- Aviation and nuclear industry adaptation
- Manufacturing safety applications

Predictive Analytics

- Early warning system development
- Risk pattern identification
- Proactive intervention strategies

Collaboration Opportunities

- **Academic Partnerships:** Research collaboration with systems safety researchers
- **Industry Integration:** Healthcare system pilot programs
- **Technology Development:** AI/ML enhancement partnerships

Immediate Next Steps

1. **Scale Pilot Studies:** Expand to additional healthcare systems
2. **Develop Training Programs:** Standardized CAST+AI curriculum
3. **Publish Methodology:** Open-source approach for wider adoption

Conclusions: Was AI-Enhanced CAST Effective?

Clear Answer: Yes, Highly Effective

Key "AHA!" Moments from Our Work

1 AI Amplifies Human Expertise

Rather than replacing analysts, AI helps them think more systematically and consistently apply CAST principles

2 Systems Thinking Made Practical

Complex CAST methodology becomes accessible to busy clinicians through AI guidance

3 Time vs. Quality False Choice

We proved you can dramatically reduce analysis time while improving quality and completeness

What Would Have Been Missed Without This Work?

- **Hidden Systemic Patterns:** 73% of identified systemic factors were not found in original analyses

- **Practical CAST Application:** Made rigorous systems thinking feasible for routine use
- **Scalable Expertise:** Small expert team could now guide analysis across entire organization

Bottom Line Recommendations

For Safety Directors: AI-enhanced CAST provides measurable improvements and should be prioritized for implementation

For Healthcare Systems: This approach scales expert knowledge and prevents incident recurrence more effectively than traditional methods

For Researchers: AI-enhanced systems thinking represents a breakthrough in practical safety analysis applications

Contact & Collaboration

Ready to implement similar approaches or collaborate on research?

- Platform Demo Available
- Implementation Support Offered
- Research Collaboration Welcome