Complex Systems, Theory of Constraints, and the Search for Inherent Simplicity

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My intention

• TOC is a broad and growing body of knowledge

• **Contradictions** with other approaches may appear as conflict.

• Finding the **inherent simplicity** enables synergy between methods (e.g., TOC, Lean, Six Sigma).

• The Cynefin Framework can help make sense of the synergy, show methods in their appropriate context, show why TOC methods are successful, and provide insight into finding Inherent Simplicity.
Familiar terms and concepts

- Don’t confuse correlation with causality
- Many approaches work—in the right context.
- Local actions should align with global goals
- People follow familiar patterns and don’t think through situations logically.
- Complex systems can be managed by relatively few control points and by increasing or relaxing constraints.

- Simple, Complicated, Complex, Chaotic/Chaos
The Cynefin Framework

• Created by Dave Snowden, founder and Chief Scientific Officer of Cognitive Edge LLC

• Cynefin is Welsh for “the place of your multiple belongings, of which you can only be partially aware”

• Primary references:
  - http://www.cognitive-edge.com
  - Wikipedia entry on Cynefin
Sensemaking

- Sensemaking: How we make sufficient sense of what’s going on so that we can act appropriately.

Initial Question: Are these two sides of the same coin?
- How to make sense of the world so we can act in it
- Finding the Inherent Simplicity in order to live a Full Life
Three Types of Systems

• Ordered Systems
  - System constrains all agent behavior.
  - Predictable and obvious, cause and effect clear to all

• Chaotic Systems
  - System and agents are unconstrained
  - Predictable through probability and statistics

• Complex Systems
  - The system lightly constrains the agents and agents are constantly modifying the system.
  - Results can be influenced/guided, but are not predicted in advance. Emergence of beneficial and harmful patterns.
The Cynefin Model

Complex

Cause and effect only clear in retrospect.

*Probe - Sense - Respond*

*Emergent* practice.

Complicated

Cause and effect requires analysis and/or expert knowledge.

*Sense - Analyze - Respond*

*Good* practice.

Complicated

Cause and effect obvious to all, one “right answer”

*Sense - Categorize - Respond*

*Best* practice.

Complex

No relationship between cause and effect at systems level.

*Act - Sense - Respond*

*Novel* practice.

Chaos

Disorder

Simple
Context: Computer Problem

Complex

Expert tech support:
Run tests to see what happens.
Zero in on fix.

Probel-Sense-Respond

Computer hit by virus:
Pull plug out of the wall.
You’ll accept help from anyone

Act-Sense-Respond

Complicated

Elevated tech support:
Ask questions to determine what the problem is.

Sense-Analyze-Respond

Entry level tech support:
Follow scripts prepared in advance of common problems.

Sense-Categorize-Respond

Simple
Implications of tools in context

Complex

• TRIZ
• DeBono’s Lateral Thinking

Disorder

Complicated

• Design of Experiments
• Six Sigma
• Value Engineering
• Statistical Process Control

Chaos

• Whatever works.
• Best advice: Don’t go here!

Simple

• 5 Whys (or 2 Whys)
• Fishbone diagram
• Best Practice documents
• Trial & Error Kanban
• Andon cords
How TOC can use Cynefin

• Common problems have common TOC solutions.
• Experience and learning helps us make sense of the situation. We see the problem and solution.
• But the people don’t. They’ve been trying to solve it and can’t. They’re in Disorder.
• We can use the Cynefin Framework to help bring people out of Disorder and provide a context for appropriate action.

Remember the layers of resistance
How a problem initially looks

Things we’ll know after they happen

Things only experts know

Things no one knows

Things everyone knows
Unclear problems, unclear solutions

Complex
“We need to run some tests and come up with some ideas for a focus group.”

Complicated
Expert 1: “Let me solve it!”
Expert 2: “No, me.”

Disorder

“We need strong leadership. Put me in charge, give me ultimate power and I’ll fix it.”

Chaos

“We need to go back to what’s worked in the past. We need to follow one common, standard process.”

Simple
Cynefin Contextualization

Things we’ll know after they happen

Things no one knows

Things only experts know

Things everyone knows

Build the model with their issues

Complex

Complicated

Chaos

Simple
Taking action

**Complex**
Gather coherent theories and ideas.
Set boundaries

**Complicated**
Analysis is required.
Choose an expert and assign the issue to them.

**Chaos**
Immediate action required.
Assign leader and act.

**Simple**
We all agree on what needs to be done. Assign action items.
Using the Cynefin Model

Complex
Empowered cross functional teams. Experiment, test, fail. Skilled people with common product level focus and distributed authority. “Look ahead” metrics

Complicated
Experts find answers (conflicting advice), synchronize cross functional efforts to maintain integration, use Good Practices.

Chaos
Leader with small crisis team react fast to reestablish order. Use whatever works, there is no one right answer.

Simple
Strong centralized authority to enforce standards and react, find root cause and correct, document as Best Practice.
Avoiding common traps

Complex

Insufficient boundaries, not enough direction.
Too much direction, trying to manage with detailed schedule instead of a plan, oversimplifying complex issues

Complicated

Overconfident experts trapped in silos, analysis paralysis, blocking new ideas coming from non-experts

Chaos

"Cult of the leader," using Command & Control longer than needed. Rush to get back to Simple without resolving core conflict

Simple

Complacency, no challenge to status quo, over reliance on Best Practices if context changes (will drive system into Chaos)
The Appropriate and the Extreme

- Complex
  - Capitalize on opportunities
  - Undirected self-organization
- Complicated
  - Appropriate use of expert analysis
  - Experts in silos
- Complicated
  - Appropriate Standards and processes
  - Stifling bureaucracy
- Simple
  - Innovation
  - Complete anarchy
- Chaos
  - Disorder
Patterns and Solving Problems

• One of the greatest advantages humans have is our brain’s ability to use patterns.
  − We don’t have to relearn things and can act fast.
  − Patterns develop from experience and listening to stories.

• Patterns are seductive traps. We can only come up with breakthrough solutions when we break the patterns.

• We can break the patterns by learning to think.
Pattern entrainment

Complex

The Domain Master
“I see it.”

The Great Leader
“My superior talent and ability shows me the answer.”

Complicated

Expert Entrainment
“My expert analysis shows that I’m right and you’re wrong.”

Leadership Entrainment
Bureaucratic Entrainment
“The process (recipe) is correct, follow it.”

Simple

Disorder

Chaos
Contradiction creates Conflict

Complex

Complicated

Pressure to complicate:
“Our industry is much more complex than that.”
“If it was that simple we’d know about it.”

Pressure to simplify:
“Why do you make it so difficult to understand?”
“Our business is different.”
“We only want 2 metrics.”
“We want only one process”

Chaos

Simple
A familiar conflict

Because: Our products and processes are complicated. Right answers require expert analysis and precision.

Because: Our products and processes fall in the Simple Domain, they can be executed with simple, basic controls.

Risk: Over Complicate

We need to …

Create an optimized plan and re-optimize as we go along

Manage using methods appropriate for Complicated Domain. (More complicated)

Conflict!

Risk: Over Simplify

In order to …

Successfully manage a large project/program

Keep things simple (Be stable and predictable)

Manage using methods appropriate for the Simple Domain. (Simpler)
Lessons Learned...Maybe

• After any major project if we conduct lessons learned we will almost inevitably conclude:
  
  “We didn’t go into enough detail to see the problems and didn’t do enough status reports.”

• This drives “Detail-itis”
  
  • “We need more detailed, precise schedules”
  • “We need more accurate forecasts”
  • “We need more accurate stock records”
The real issue is Complexity

Complex
But what if much of what we do is really in the Complex Domain?
Hint: Much of it is.
Inherent Simplicity

Complicated
Pressure to complicate

Disorder

Chaos
Pressure to simplify

Simple
Attributes of Complex Systems

- Large number of interacting elements
- Non-linear interactions
- Solutions emerge from dynamic circumstances
- Elements evolve together in irreversible ways
- Hindsight cannot lead to foresight

Managing Complex Systems

• Use boundaries (constraints) and attractors to manage the emergence of beneficial patterns.

• Rapid and frequent scanning and action
  − See, Attend, Act (Gary Klein)
  − Observe, Orient, Decide, Act (Col. John Boyd)

• Anticipatory awareness (weak signal detection), experience primed pattern recognition
Paying attention to weak signals

Sometimes the little boy cries, “Wolf” and there is no wolf.

Sometimes there is.
Necessary characteristics

- Distributed Cognition
- Fine Granularity Objects
- Disintermediation
Distributed Cognition

- Need for weak signal detection means everyone must be alert and aware of emergent patterns.
  - Wisdom of crowds, people’s sense of how things are going
  - Example: Pre-Mortem (Gary Klein)
  - Example: Roundabout instead of traffic lights

Awareness is distributed, not centrally controlled.
Fine Granularity Objects

- Over simplifying Complex Systems drives them into Chaos. Details are important.
  - Sufficient detail to see emergent patterns
  - Be alert to the time scale: Consider difference between Twitter, Blog, Web Site, Newspaper, Magazine, Book
  - Example: Each person gives remaining duration status.
  - Example: No more than 300 tasks in a project plan.

BUT, for large projects use sub-projects and/or checklists
Disambiguation

Decision makers can access information directly without filtering

- Example: CEO reads all incoming customer email
- Example: Buffer Management meetings: “What’s going on? What are we doing about it? Do you need any help?”

Filtered

“Based on the average status, we’re expecting to release on time.”

Unfiltered
TOC through a Cynefin lens

Task: implement Critical Chain Project Management in organization with widespread multi-tasking and strong milestone driven approach to project management.

**Complex**

1. Overly constrained schedule
2. Multi-tasking chaos
3. Mandated priority, no multi-tasking, freeze 25%, limit incoming work (Imposition of constraints to restore order)
4. Scheduling staff experts with “Detail-itis”

**Complicated**

5. Shallow dive into Chaos, where expertise is of limited value
6. Multiple safe-fail experiments (pilots)
7. Planning, scheduling, commitments made with CCPM
8. CCPM in execution (Buffer Management)

**Chaos**

**Simple**
CCPM through a Cynefin lens

CCPM is in Chaos, Simple, Complicated, & Complex.

- **Complex**: Execution, Buffer Mngt
- **Complicated**: Planning
- **Chaos**: Prioritize and Freeze is Chaos
- **Simple**: Planning is Complicated.
- **Simple**: Execution is Complex.
- **Simple**: Many tasks are Simple.
Cycling between domains

Complex \hspace{1cm} \text{Complicated}

Exploration \hspace{1cm} Exploitation

Disorder \hspace{1cm} Unstable \hspace{1cm} Stable

Chaos \hspace{1cm} Simple

Complicated and Complex: Natural path of discovery and analysis. Common to product development.

Simple and Chaos
Simple to Chaos is as easy as falling off a cliff.
Chaos to Simple is difficult.

Watch for informal organizations
Watch for Informal organizations

The presence of strong informal, shadow networks can be a bad sign.

• If process descriptions are overly simple or bureaucratic, informal *work-arounds* will form.

• Informal networks are countermeasures that enable the formal network to *appear* to function.

• When the formal and informal networks can no longer cope the system fails catastrophically.
The Thinking Process in the Model

Complex
Necessity and Sufficiency logic tools create resilient pathways.
“Find a way to…”
Flying pig injections
S&T concepts

Complicated
Thinking Process excels.
Analysis of core problems and solutions. Superb at explanations.
“If A, then B” S&T detail

Disorder
Thinking Process works fine, but--
“That’s obvious”

Chaos
Impose constraints.
Guidance from 5 Focusing Steps and Flow.

Simple
Pattern entrainment

- **Complex**
  - The Domain Master
    - “I see it.”

- **Complicated**
  - Expert Entrainment
    - “My expert analysis shows that I’m right and you’re wrong.”

- **Chaos**
  - The Great Leader
    - “My superior talent and ability shows me the answer.”

- **Simple**
  - Leadership Entrainment
    - Bureaucratic Entrainment
      - “The process (recipe) is correct, follow it.”

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Time to develop expertise

**Complex**
- Skill: 10000 hours,
  5 years full time,
  10 to 20 years elapsed

**Complicated**
- Skill: 1000 hours,
  .5 year full time,
  1–3 years elapsed

**Chaos**
- Skill: Instinctual
  Born with it or lucky

**Simple**
- Skill: 10 hours
  People are interchangeable

Domain Masters

Trained experts

Ref Noah Raford
Learning from the Domain Masters

- Complex Domain Masters often solve problems by “experience primed decision making”

- They seem to “just know” the answer because of their long study and experience.

The samurai practices night and day until “sword becomes no-sword, intention becomes no-intention.”

“Practice is the only way that you will ever come to understand what the Way of the warrior is about… Words can only bring you to the foot of the path…”

“The Book of Five Rings”

Miyamoto Musashi

“Fidelity in Revenge” portrait of Musashi
Painted by Kuniyoshi, circa 1848
Many Complex Domain solutions look obvious in hindsight.

- A Domain Master may solve a problem in the Complex Domain and then explain the solution as if it was in the Complicated Domain.

- “Obvious solutions” can lead to tautologies and only noticing what’s noticeable.

- *The Inherent Simplicity is the spark that starts the solution. It is the essence of Sensemaking.*
Put Sensemaking before solutions

For this to work, we must demonstrate how the management work load will be reduced

Rees Furbeck, Some Thoughts on Using the Theory of Constraints for Very Large, Complex Projects, TOCICO, 6/8/2009
Emergence of Inherent Simplicity

The Cynefin Model helps us make sense of the world.

• Life is complex.
• People are complex.
• Business is complex.

TOC provides the tools to find the Inherent Simplicity and the opportunities the complexity provides.

• How to make sense of the world so we can act in it
• Finding the Inherent Simplicity in order to live a Full Life
The one thing we can count on

- Each time we reach a new level of understanding we’ll look back and say:

  Why did it take me so long to see this?
  It’s so obvious.
  After all, it’s just common sense.
References:

- Dave Snowden: blog, papers, presentations  http://www.cognitive-edge.com
- Noah Raford: blog, presentations  http://news.noahraford.com
Steven C. Holt has been at Boeing for over 30 years, in management and engineering. During that time he has had the opportunity to study and practice a number of continuous improvement disciplines such as Total Quality Management, Systems Thinking, TRIZ, Lean and the Theory of Constraints. He received his initial TOC training through Washington State University in 1997 and holds a Constraints Management Certificate from WSU. He has been a member of TOCICO since 2003. Steve is TOCICO certified in Project Management and is on the TOCICO Project Management Subcommittee. His primary focus is the application of TOC in the management of complex product development programs.