32nd Annual INCOSE international symposium

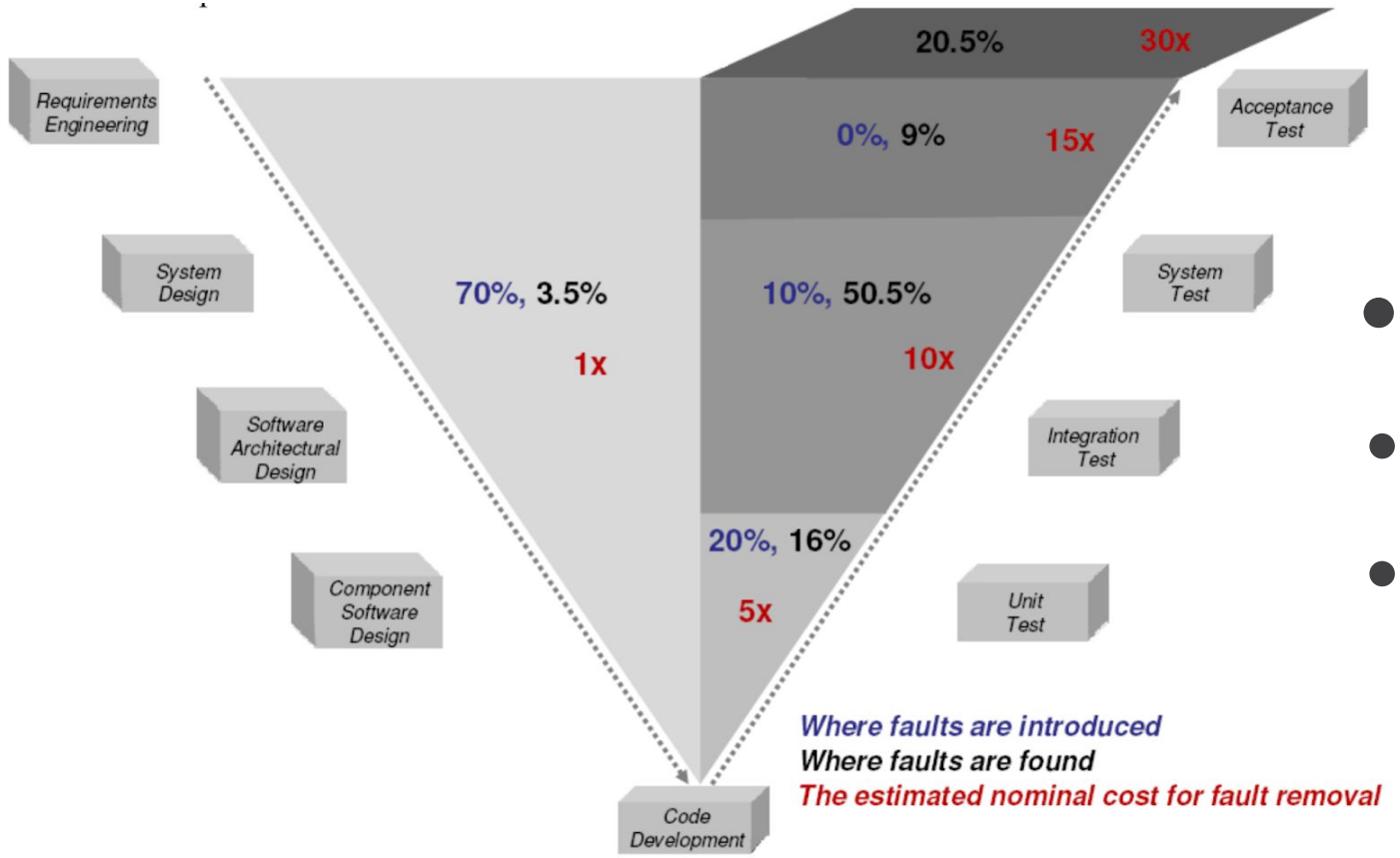
hybrid event

Detroit, MI, USA
June 25 - 30, 2022

Managing Complexity through Collaborative Intelligence

www.incose.org/symp2022

The Problem with Complexity in Aerospace Systems



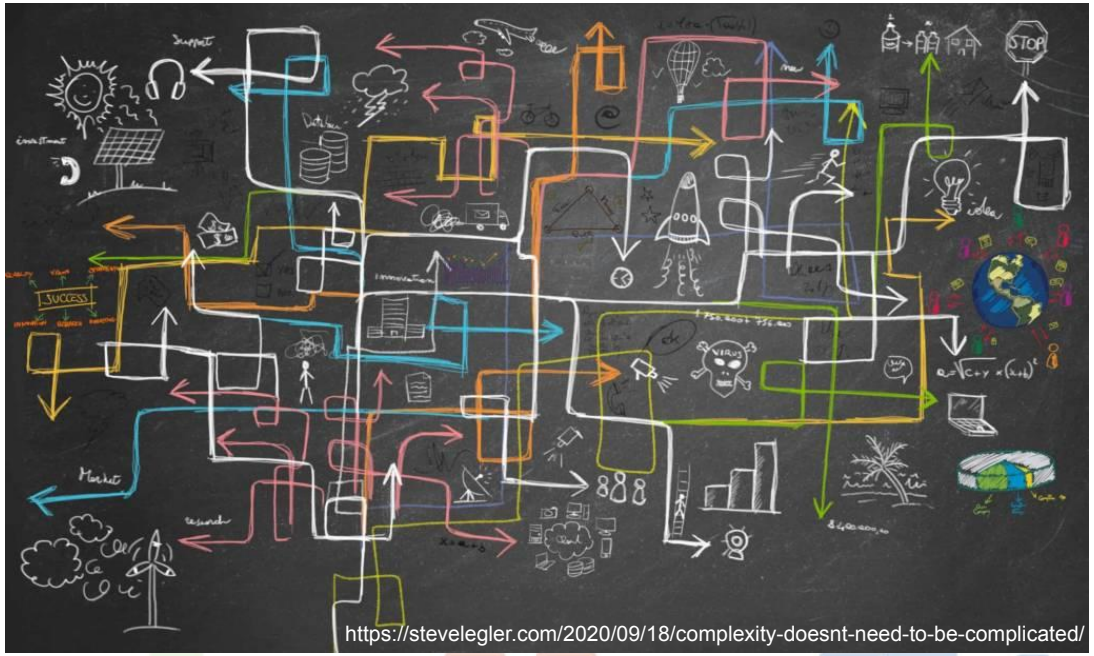
- Faults introduced early in development
- Faults found much later
- Results in program being over budget and behind schedule

Becz, S, Pinto, A, Zeidner, L, Khire, R, Reeve, H & Banaszuk, A 2010, 'Design System for Managing Complexity in Aerospace Systems', 10th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, AIAA, Fort Worth, pp. 1-7

Managing Complexity in Aerospace Systems Development

- Managing aerospace complexity increasingly requires a cognitive rather than technical solution

- Griffin suggests focus for systems engineering
  - Context over structure
  - Interactions over elements
  - The whole over the sum of the parts

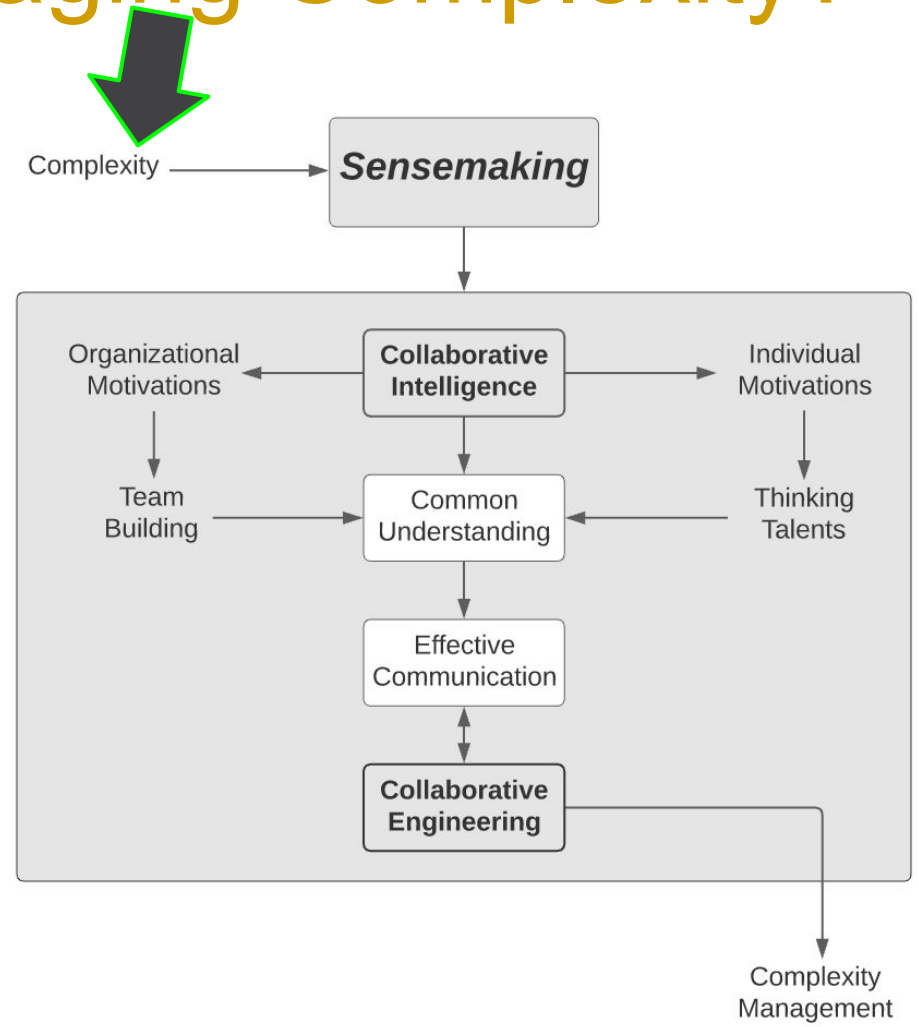


https://stevelegler.com/2020/09/18/complexity-doesnt-need-to-be-complicated/

Griffin, “How Do We Fix Systems Engineering?”, 61st International Astronautical Congress, 2010

What is the Solution for Managing Complexity?

- Manage complexity through sensemaking
  - Understanding the organization and individual motivations
- Collaborative Intelligence as sensemaking tool
- Use Collaborative Intelligence to get a common understanding
- Use common understanding to get to effective communication
- Use effective communication to get to collaborative engineering
- Collaborative engineering is a sensemaking tool for managing complexity



Sensemaking Principles

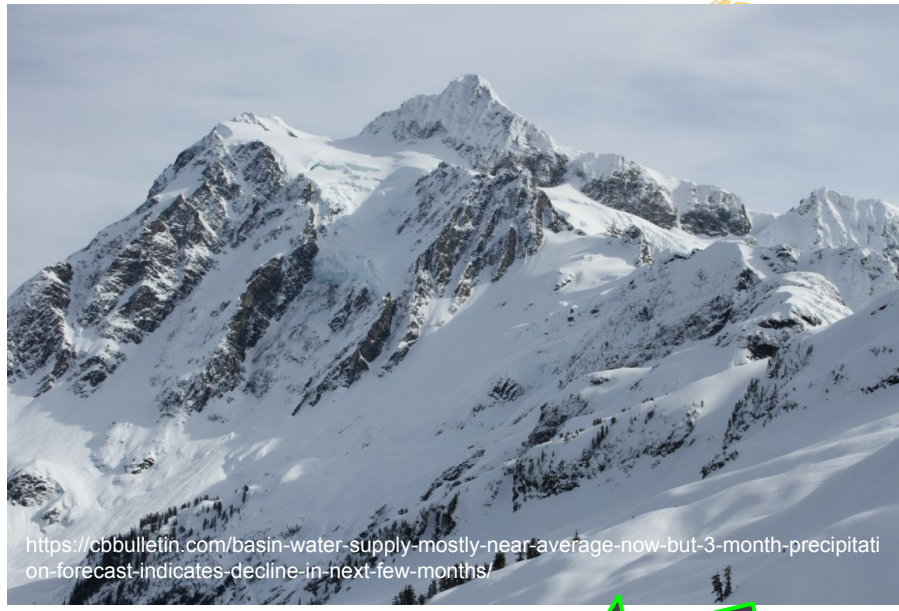
- Organizational capacities of a team are common but significant unknowns
- To have sensemaking, there must be articulation of the unknown
- Sensemaking is facilitated by a common goal
- Form understandings, test them, then refine

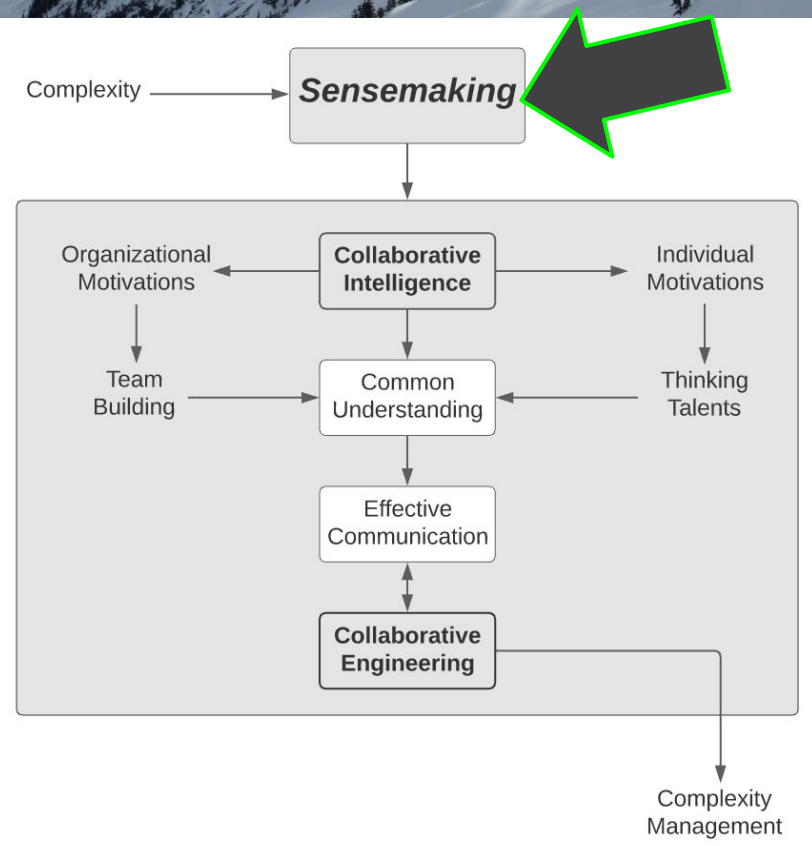
1	**Explore the wider system**	Gather data from a variety of sources
2	**Question your assumptions**	Actively pursue differing opinions
3	**Test your assumptions**	Use low risk experiments to gather data
4	**Adopt multiple perspectives**	Keep an open mind
5	**Iterate**	Refine ideas or abandon them as data indicates

Ancona, D 2012, 'Sensemaking: Framing and Acting in the Unknown', in SA Snook, N Nohria & R Khurana 2011, The Handbook for Teaching Leadership: knowing, doing and being', SAGE Publications Ltd, California, pp. 3-19.

Sensemaking Story

- A group of hikers find themselves lost
- Maps are determined to be not entirely accurate
- Pressed by urgency, they use the inaccurate maps to navigate
- Geological features don't quite line up, but they have enough information
- Hikers form a team and come up with a plan
- They find familiar landmarks and get back okay
- Maps were actually of the wrong mountains
- Moral: sensemaking requires people agree on how to achieve a common understanding


https://cbbulletin.com/basin-water-supply-mostly-near-average-now-but-3-month-precipitation-forecast-indicates-decline-in-next-few-months/



*Ancona, D 2012, 'Sensemaking: Framing and Acting in the Unknown', in SA Snook, N Nohria & R Khurana 2011, The Handbook for Teaching Leadership: knowing, doing and being', SAGE Publications Ltd, California, pp. 3-19.

Narrative Formation

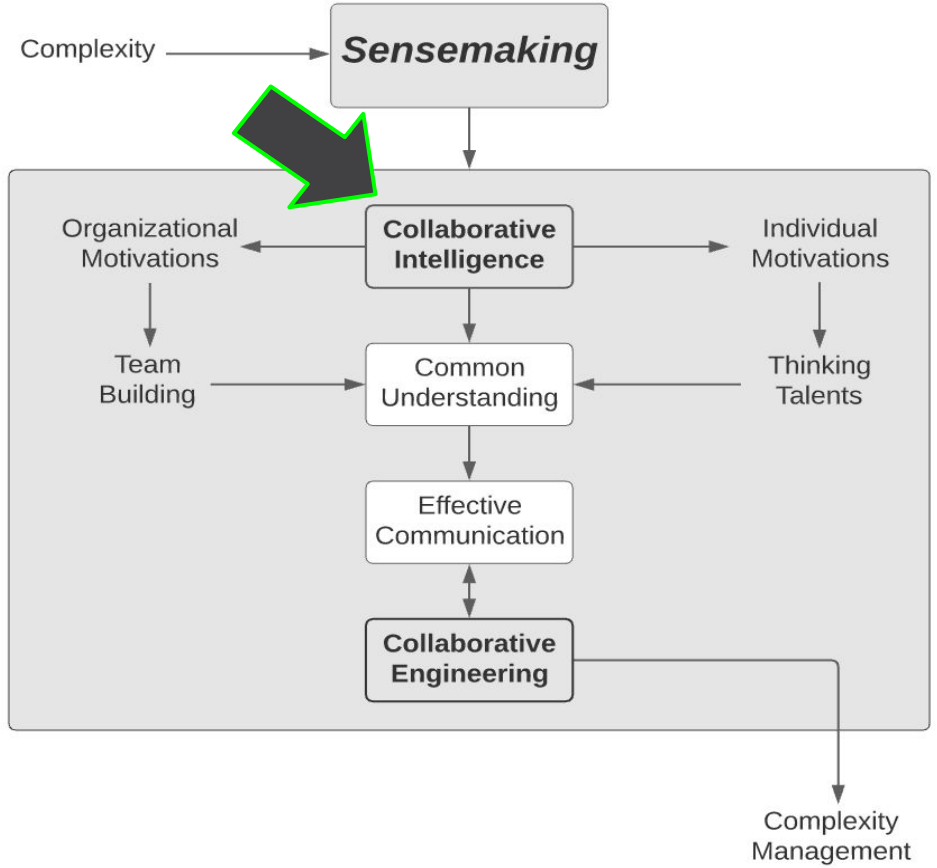
- As in the lost hikers scenario, in aerospace systems development, there is rarely a narrative to follow from the start
- The map that the hikers use is represented by the many pers that need to be synthesized into a narrative
- Sensemaking is the process of achieving a narrative from a pre-narrative
- A pre-narrative is the hiker's map of the wrong mountains
- Collaboration among colleagues in this process allows organizations to make sense of the problem

Jaatinen & Lavikka, Common Understanding as a Basis for Coordination, 2008

Introduction to Collaborative Intelligence

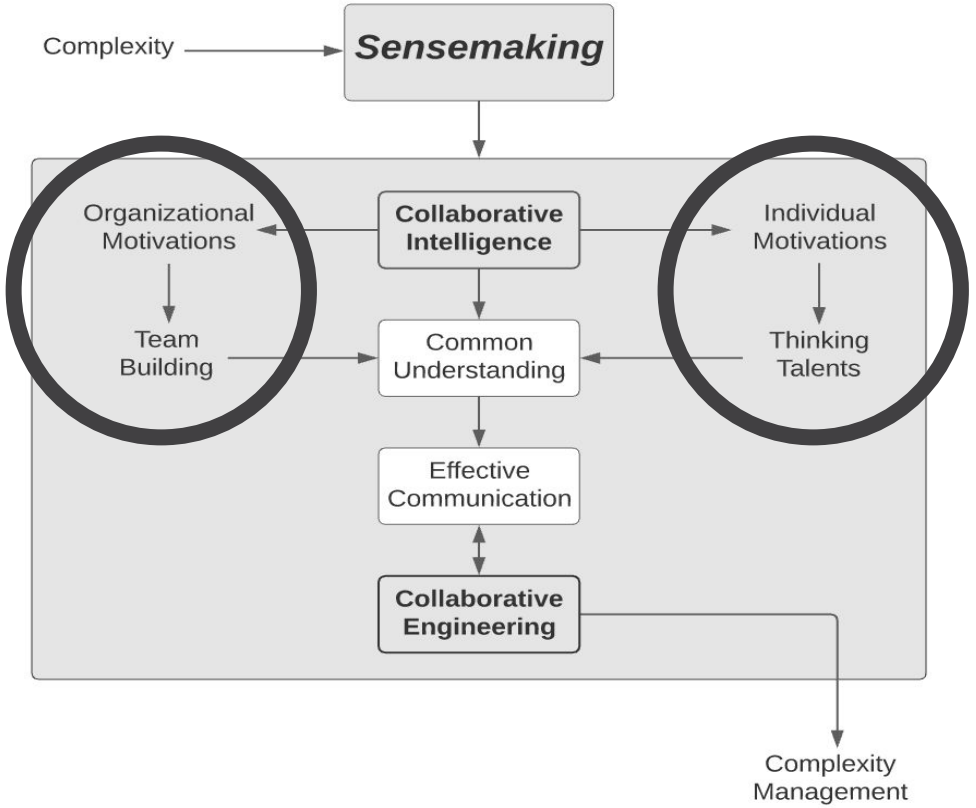
- Collaborative Intelligence is a method for achieving effective communication
  - People think differently
  - People communicate differently
  - Make best use of individual thinking and communication preferences

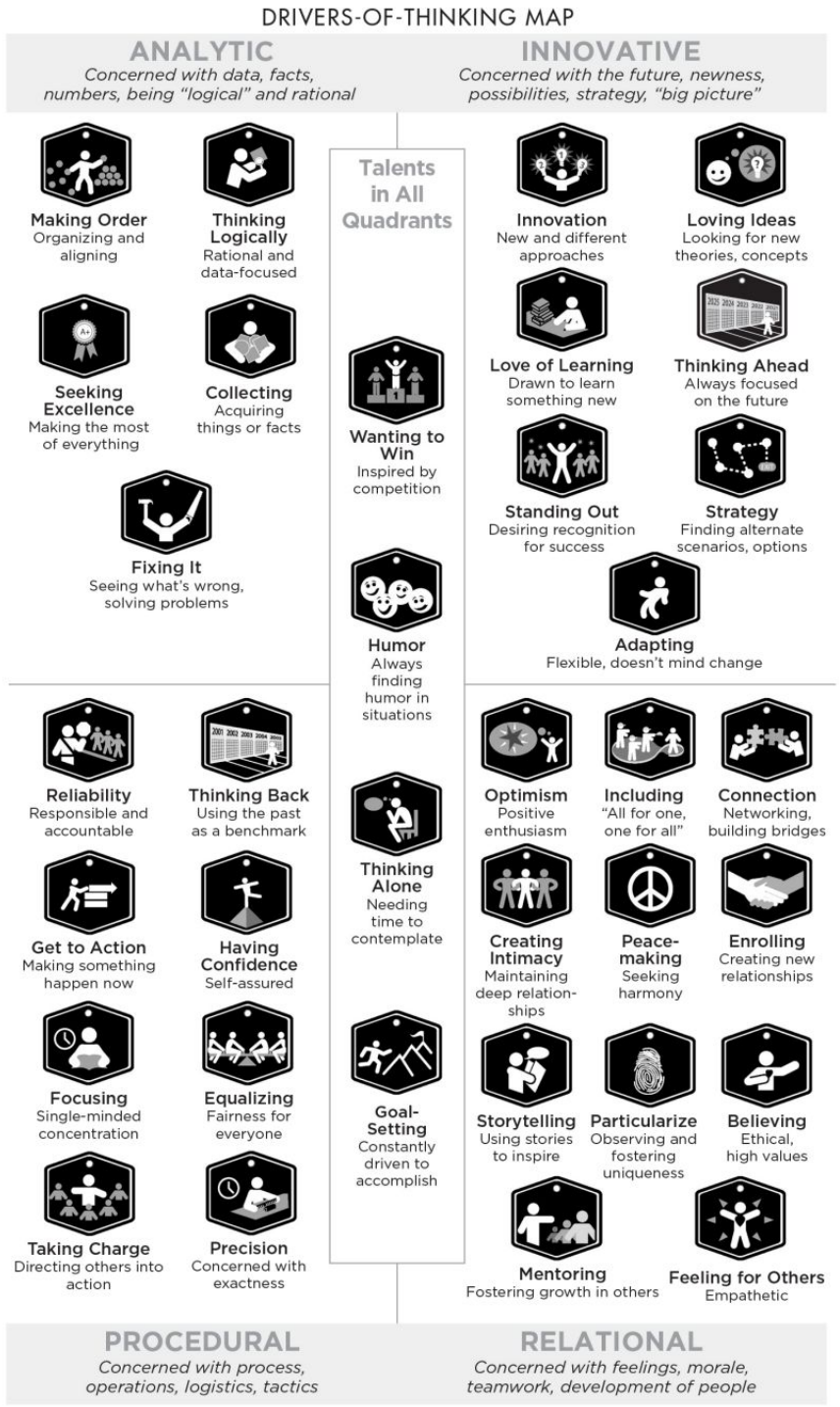
- Markova and McArthur define **thinking talents** as based on natural gifts, strengths and weaknesses
  - What energizes people based on four categories
    - Analytic
    - Innovative
    - Procedural
    - Relational



Individual and Organizational Motivations

- Individuals are motivated by a feeling of belonging and being needed
- Organizations are motivated to accomplish goals as a unit





- 35 Drivers of Thinking Map
  - What motivates people
- Thinking talents provide basis for questioning assumptions
  - Requires open mindedness
- A framework rather than simply encouraging collaboration
  - Methodically visualizing the people's communication
  -
- Quadrants represent different thinking categories
  - Analytic is about data
  - Innovative is about ideas
  - Procedural is about process and focus
  - Relational is about people
- Thinking talents are a mechanism which makes it possible for individuals to learn about their unique ways of thinking and how their way of thinking relates to others

Individual Motivations & Thinking Talents

- When others understand how we think
  - We can communicate without hesitation
  - We can be given information in a way we understand

- Talents make up our bright spots
  - Knowing what lights people up helps form a narrative to their actions

Organizational Motivations & Team Building

- Four cognitive styles encompass thinking talents
- Promote and maximize individual and shared learning
- Teams with balanced strengths can appropriately and professionally navigate differing opinions

Analytic	Concerned with data, facts, numbers, being logical and rational
Innovative	Concerned with the future, newness, possibilities, big picture, strategy
Procedural	Concerned with process, operations, logistics, tactics
Relational	Concerned with feelings, morale, teamwork, development of people

Successful Use of Thinking Talents

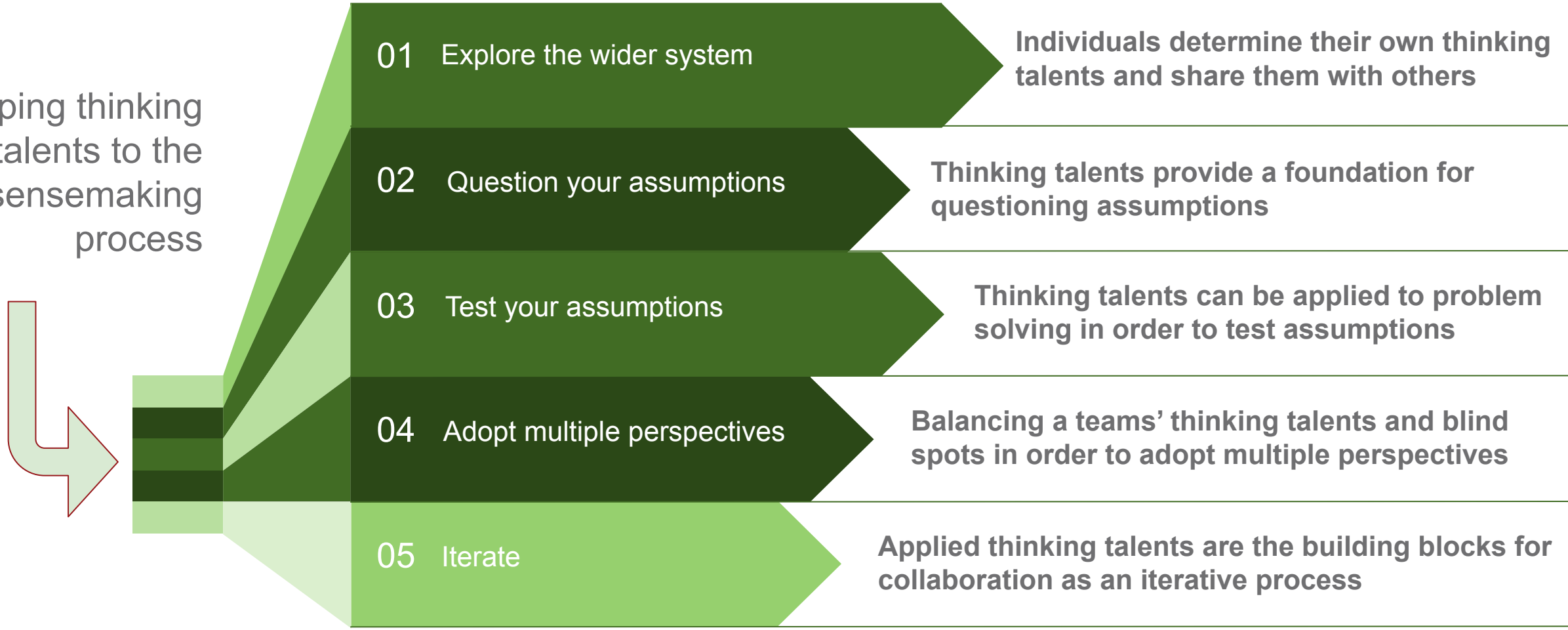
- Peter, the leader, does not know why people in his organization are falling behind and aren't asking questions
- Peter investigates his own leadership style
- Learns his leadership style has bright spots focusing on giving commands and wielding authority
- Learns through thinking talents that
  - Nothing is wrong with his leadership style
  - There are blindspots to his preferred way of doing things
- Surrounds himself with people who fill in his blindspots
- Organization succeeds because now people feel their contributions matter
- Moral: Peter achieved implementation of what did not come naturally to him by collaborating with others to fill his blindspots

What Thinking Talents Do

Thinking Talents CAN:	**Thinking Talents CANNOT:**
Quickly reveal insight into how specific individuals think	Predict individual people's behavior
Increase productive problem solving capabilities of groups	Teach people how a technical system works
Hasten learning by activating innate methods of comprehension	Lead people directly to conclusions that were not previously known
Improve team building and working partnerships in groups	Reveal people’s personalities and quirks

Mapping Thinking Talents to Sensemaking

Mapping thinking talents to the sensemaking process

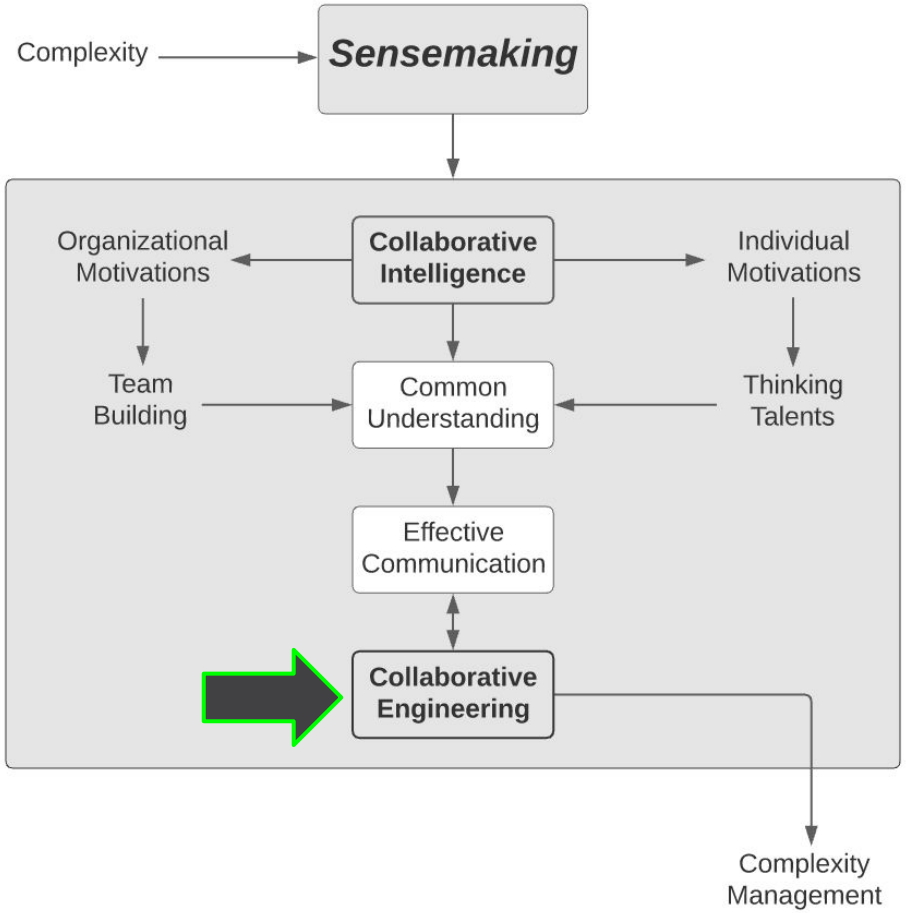


The Role of Collaborative Engineering

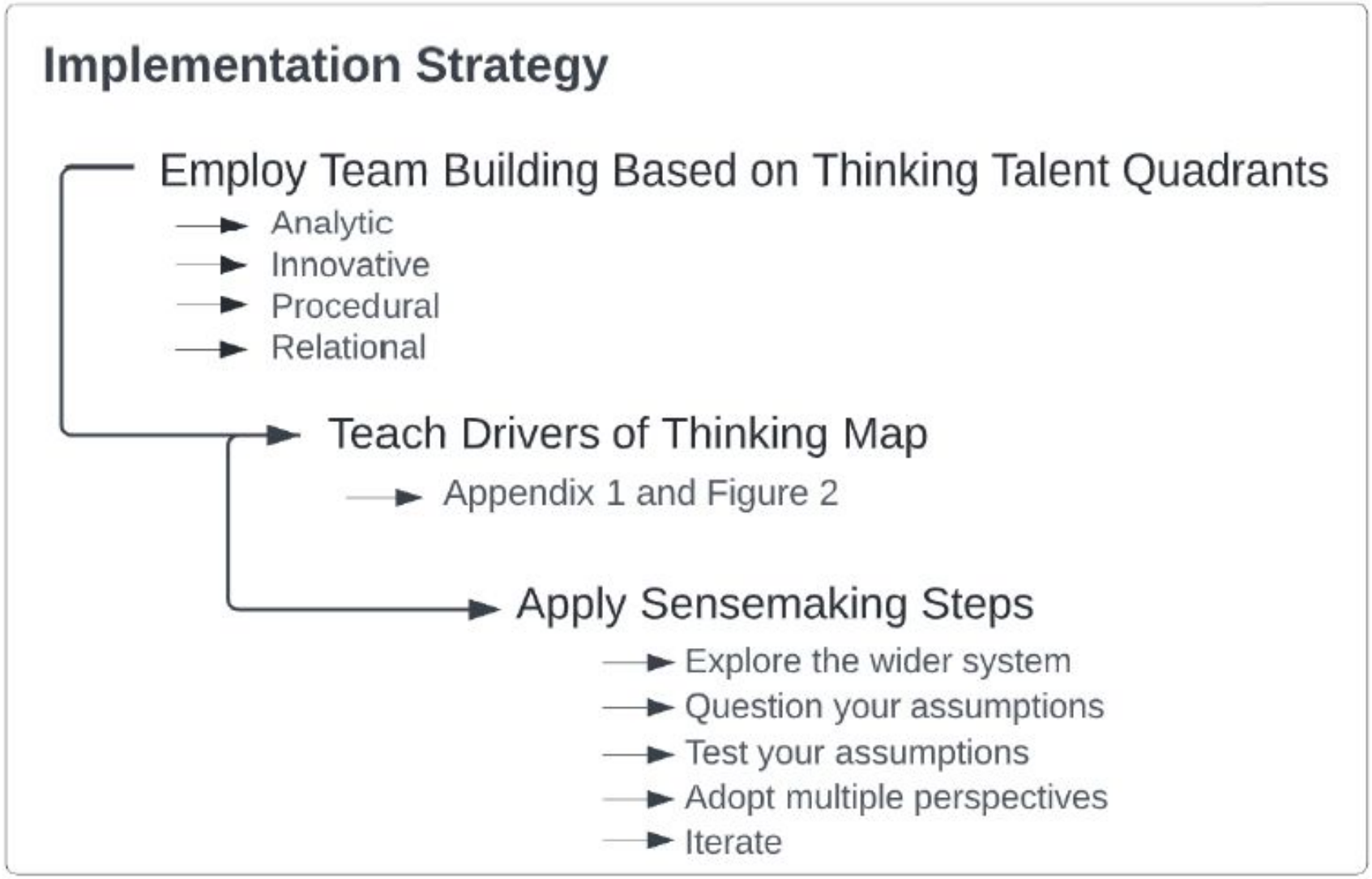
- Collaborative engineering is composed of specific practices for establishing common understanding as an essential organizational task

- “Seen through the lens of sensemaking, collaborative engineering addresses the individual’s needs as well as supporting a common understanding while solving the overall problem”

- Sensemaking includes
  - Collaborative Intelligence
  - Common understanding
  - Effective communication
    - Bright spots compliment blind spots
  - Collaborative engineering



Implementation Strategy

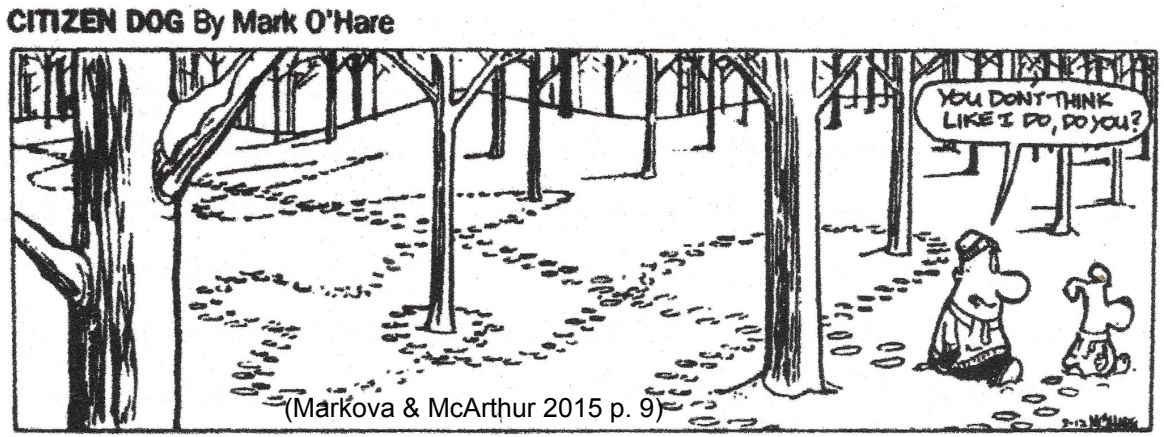


Communication without Sensemaking

- Why can’t we just implement software-tools that increase collaboration or communication?
  - Virtual whiteboards, slack/teams/skype, networked folders, etc.

Software tools: Pro	**Software tools: Con**
Software tools may actually increase collaboration	We may not know why, or how the mechanisms of, the collaboration are increased, losing out on long term effectiveness
Software tools can be customized for particular departments, projects, or timelines	These are particular solutions and do not address the generalities associated with perpetuating meaningful collaboration
Software tools often lead to more frequent communication	Insight into others’ thinking talents is underutilized, weakening potential for organizational growth
Efficiency with such quality-of-life productivity tools can be attained	Balance in teams or finding perspective is offloaded onto the individual, still necessitating cognitive tools over those made of software
Software is sometimes available in affordable, enterprise level, bulk discount packages	This is an investment in capital goods rather than one in human capital, the ladder of which is self-sustaining

Communication with Sensemaking



(Markova & McArthur 2015 p. 9)

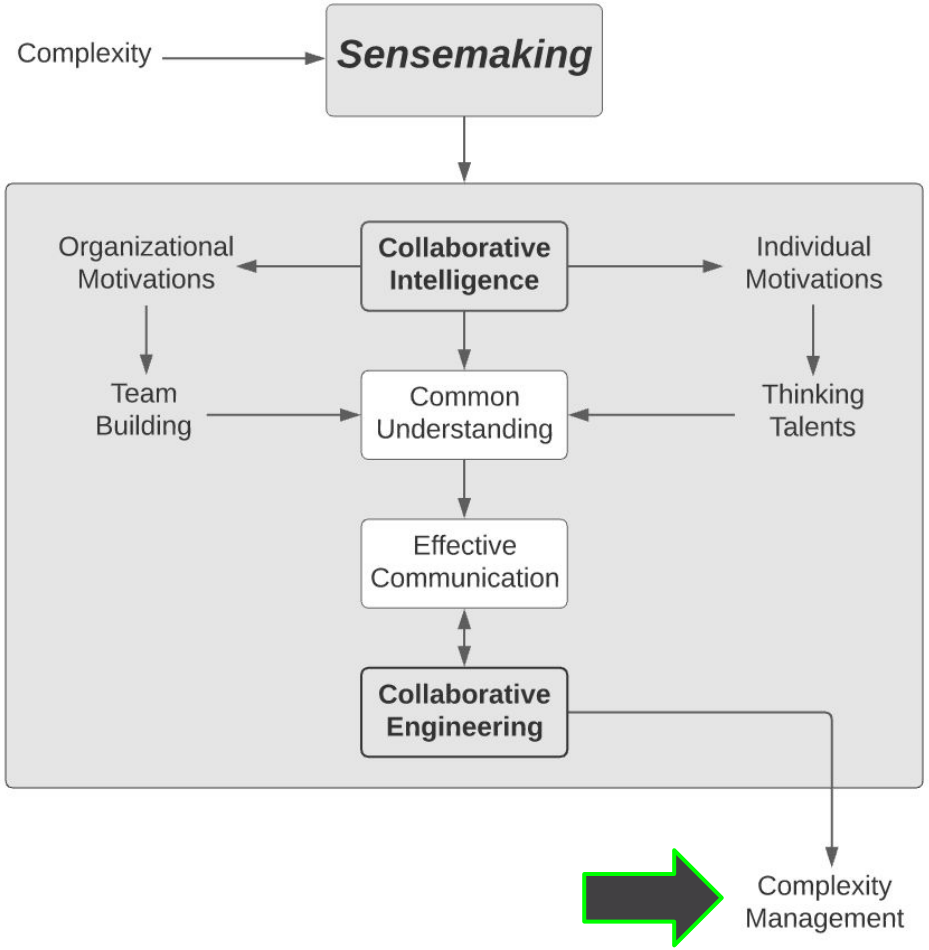
- Imagine a zoom meeting with a group of people you have never met from around the world

- Begin with everyone announcing their thinking talents and their blind spots
  - How you can most effectively communicate with them
  - Avoid counterproductive assumptions that are normally attributed to personality

- Becomes an operating manual for one another's minds

Conclusion

- Complexity is a byproduct of more functionality, more sophistication in systems development
  - Need ways to get ahead of unwanted behavior later in development process
- Sensemaking means articulation of the unknowns
  - Facilitated by a common goal
  - Form understandings, test them, then refine
- Collaborative Intelligence
  - Thinking talents help achieve common understanding
  - Organizational motivations - the team
  - Individual motivations - thinking talents
  - Both strong attributes and blind spots
- Collaborative engineering is an outcome of sensemaking
  - Improves communication
    - Find faults faster
- To manage complexity, apply sensemaking from a collaborative standpoint



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Differentiating Thinking Talents

	Personality Tests (Myers-Briggs, etc)	Thinking Talents
Reliably predict people's behavior	✗	✗
Determine preference in people’s decision making	✓	✓
Reveal what excites people into action	✗	✓

Combining Individual and Organizational Motivations through Sensemaking