

Research Paper towards the Degree of Doctor of Philosophy in Engineering

LEAN TRANSFORMATION–TOC INTEGRATION FOR HUMAN CENTRIC OPERATIONAL EXCELLENCE: A DELPHI VALIDATION

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SCHOOL OF MECHANICAL, INDUSTRIAL AND AERONAUTICAL ENGINEERING

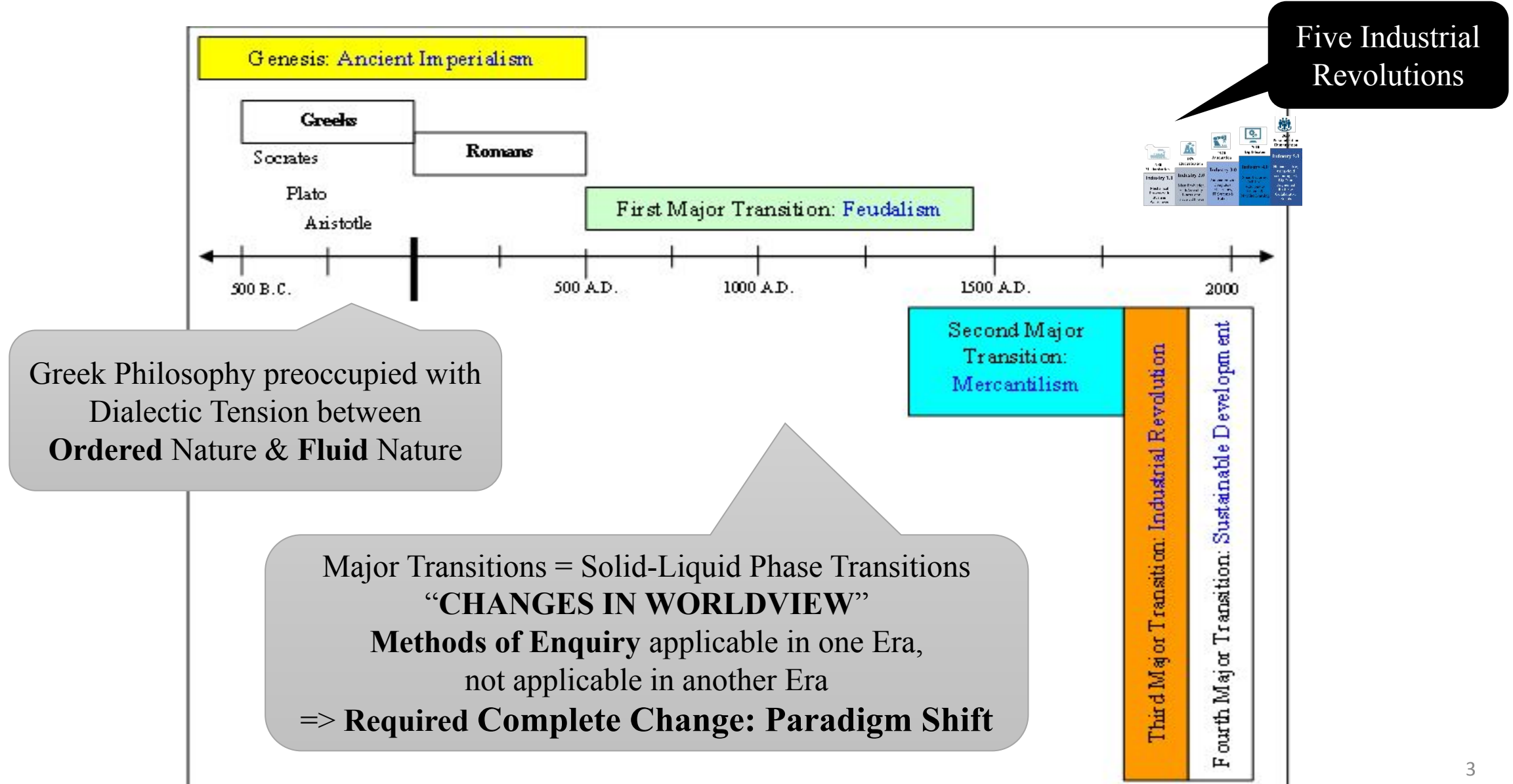
FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

UNIVERSITY OF THE WITWATERSRAND

TOC – Table of Contents

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 - Literature Reviewed
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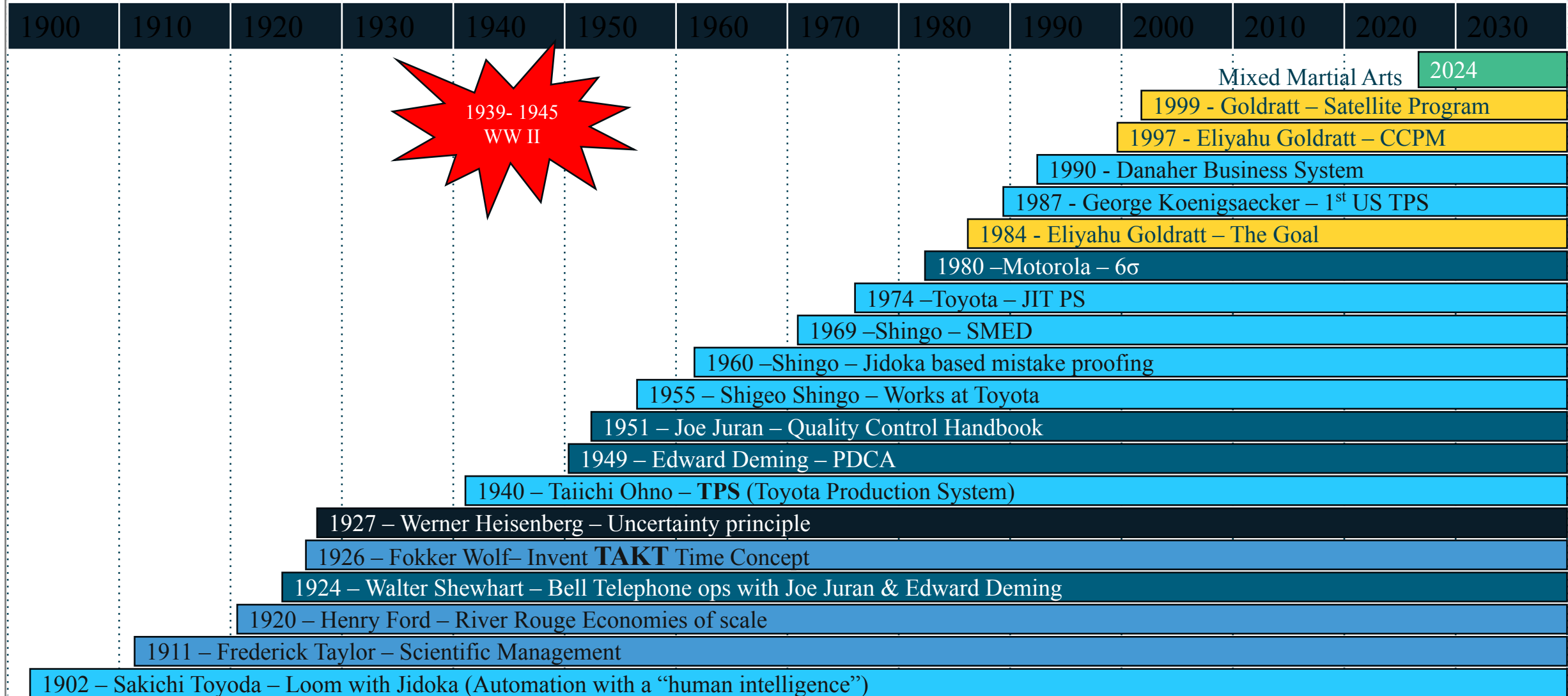
Passage through time – Economics & Science



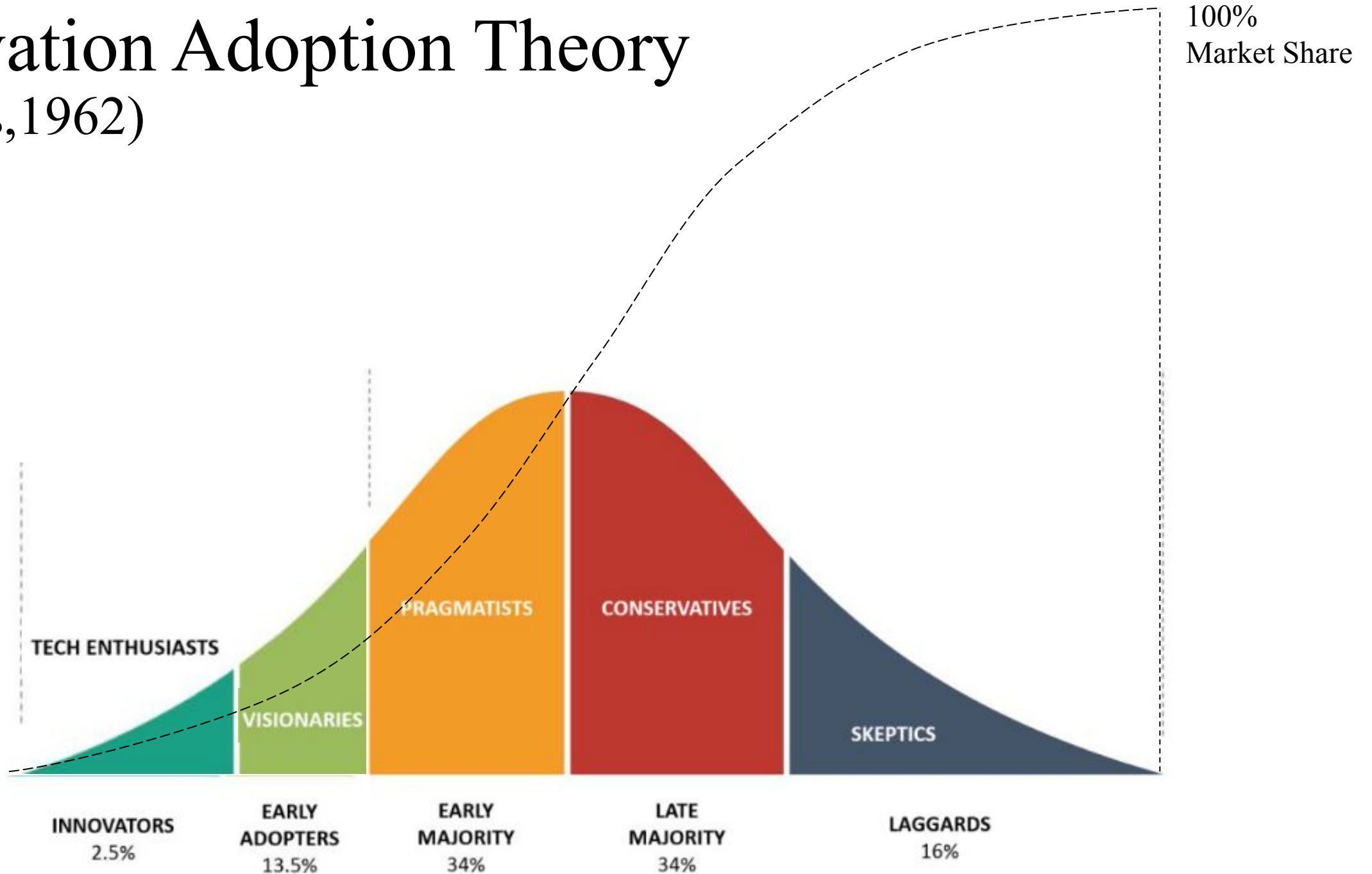


“... On shoulders of Giants...”

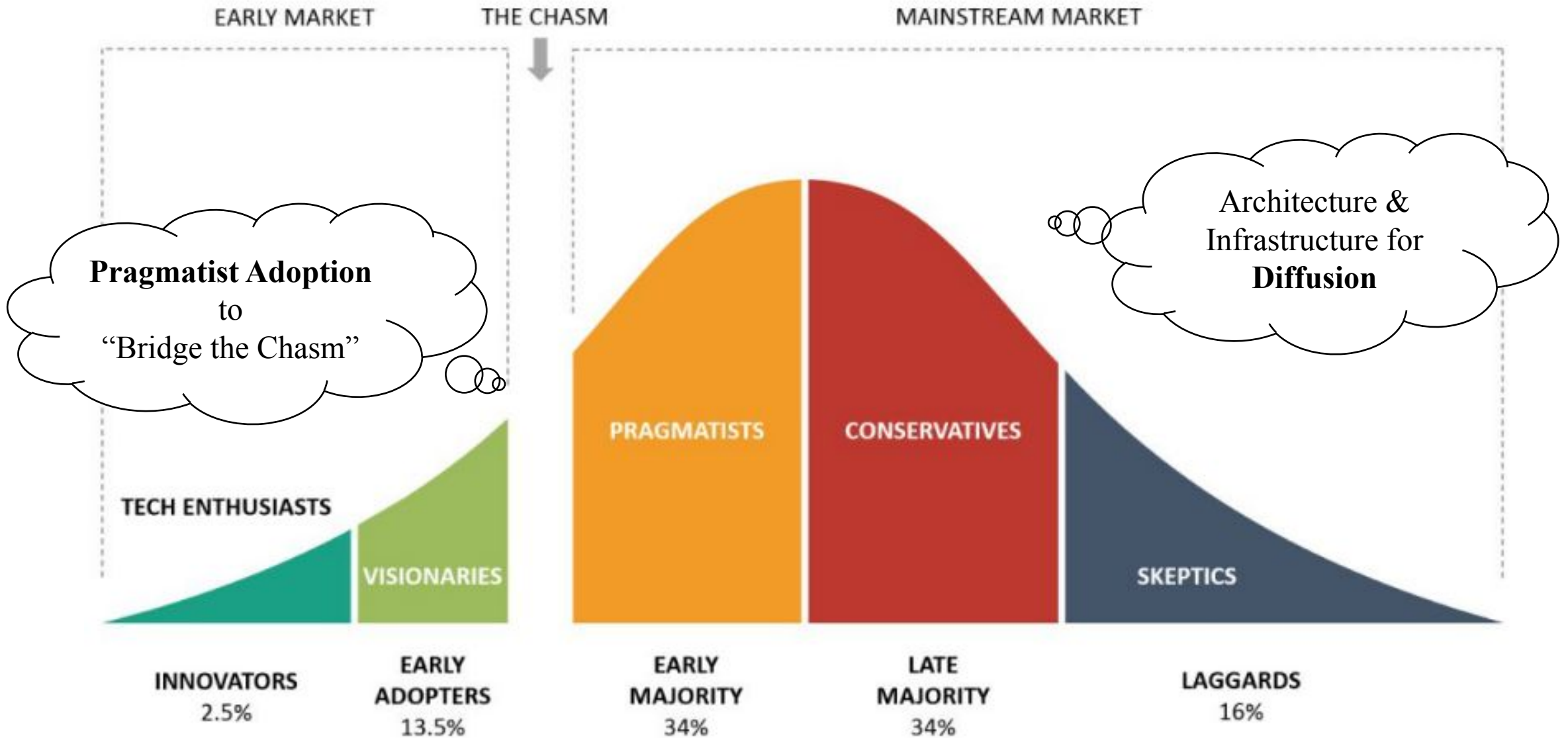
Industrial Engineering Innovation - Continuum



Innovation Adoption Theory (Rogers, 1962)



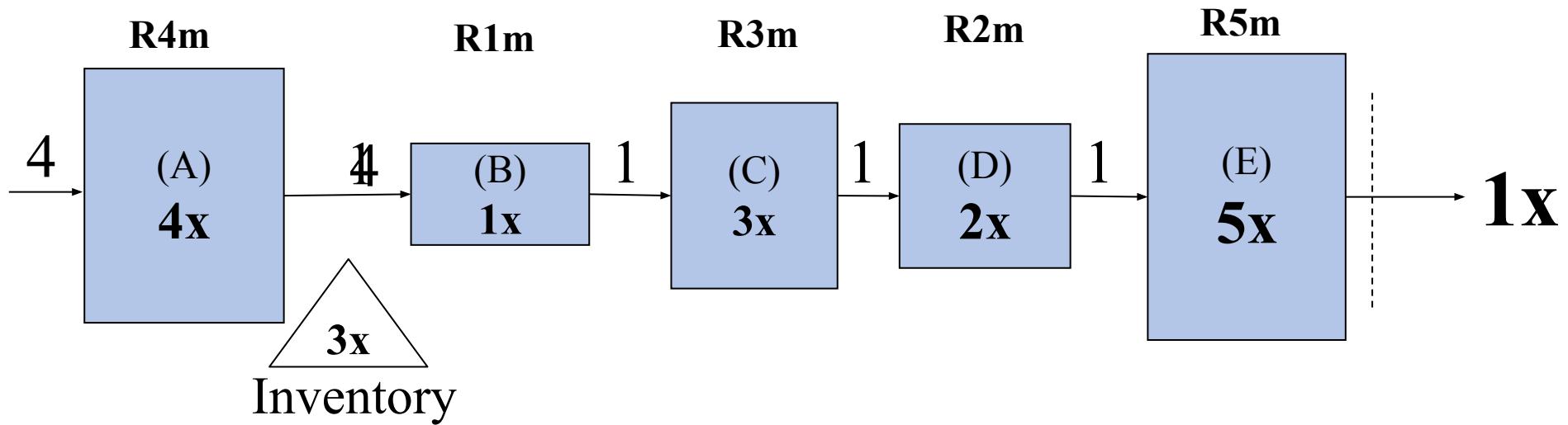
Innovation Adoption-Diffusion Chasm



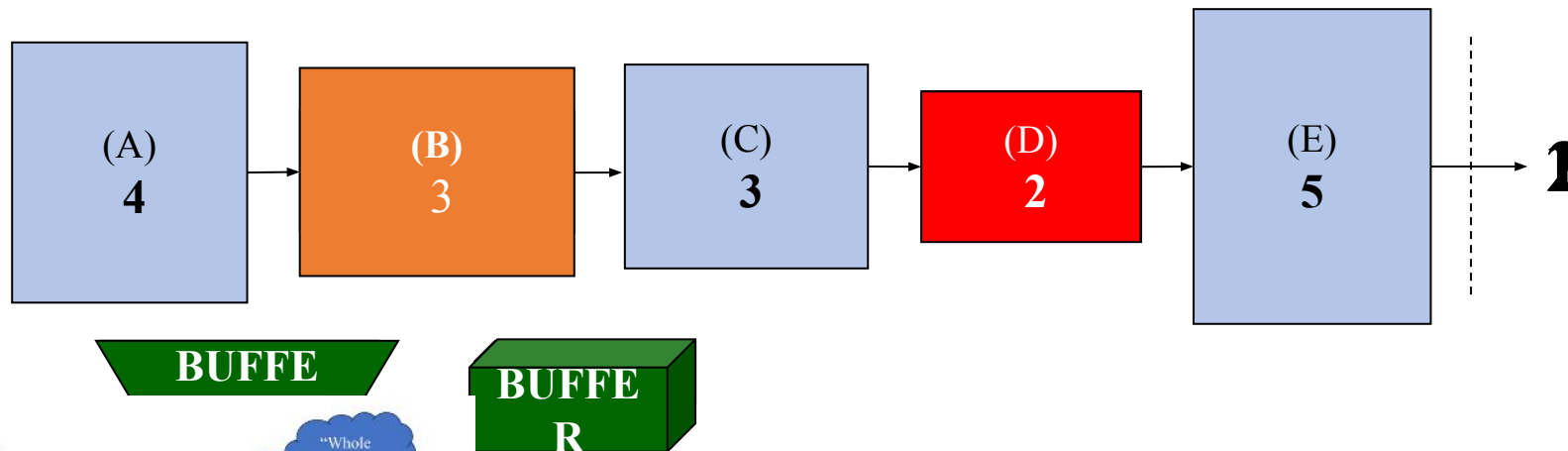
Theory of Constraints (TOC)

Literature Reviewed

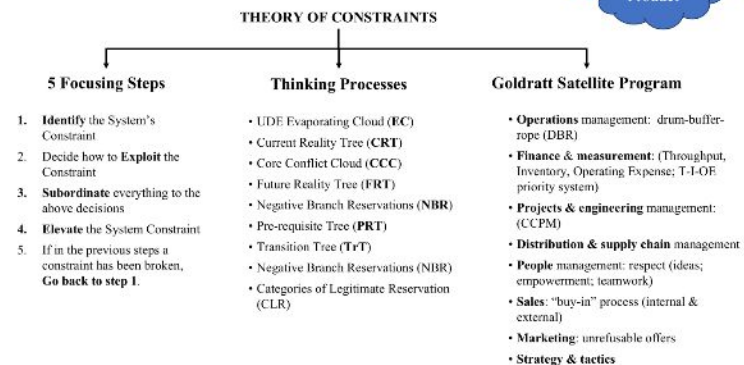
Un-Balanced Flowline: “Efficiency bias”



TOC: Focus & “Instant Gratification”



TOC Overview (2000)



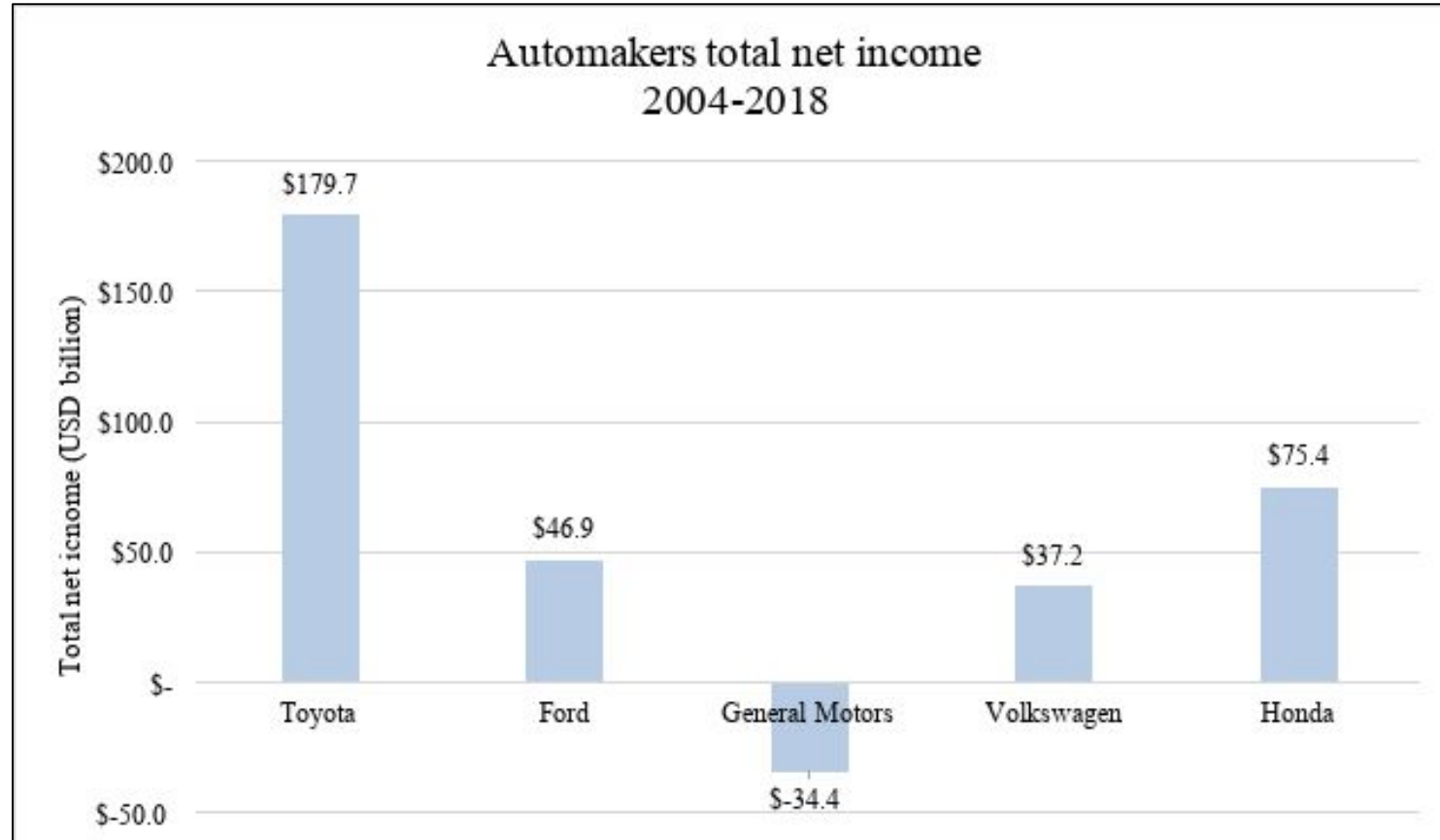
LEAN TRANSFORMATION (LT)

From Literature Review

Automakers Mystery: Total net income (14-year period)

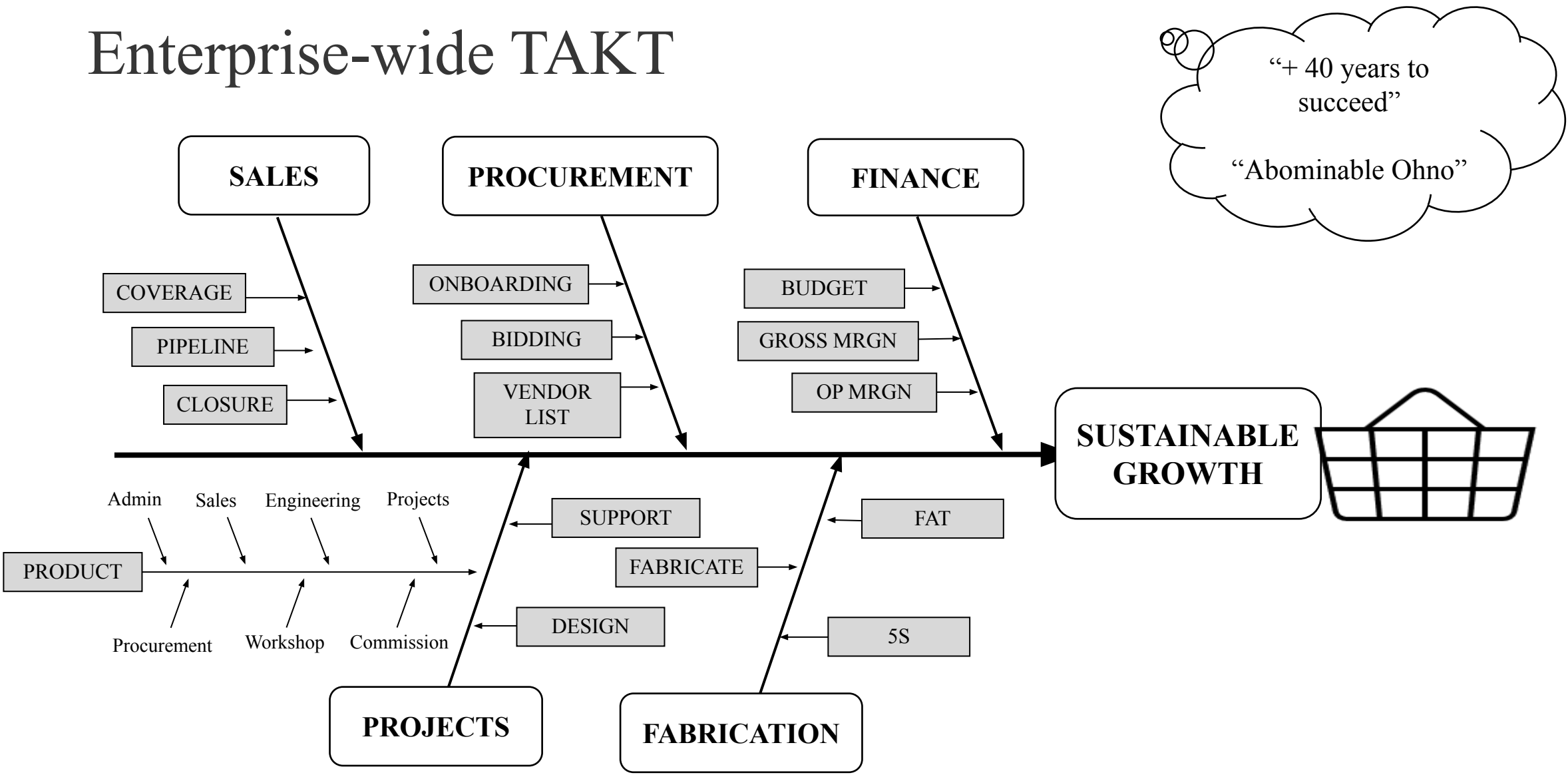
- Toyota Loonshot

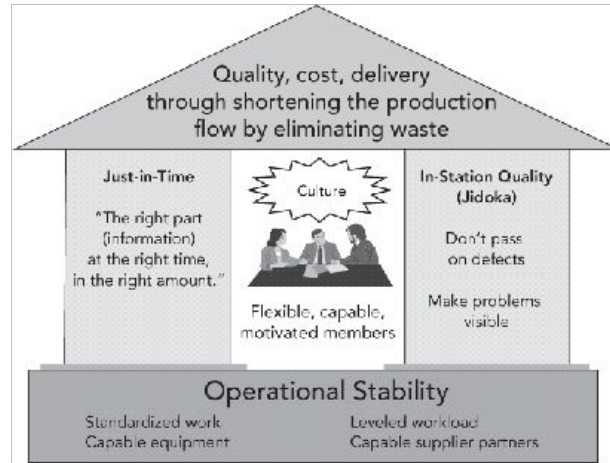
10% Success
imitating
TOYOTA WAY
Transformation



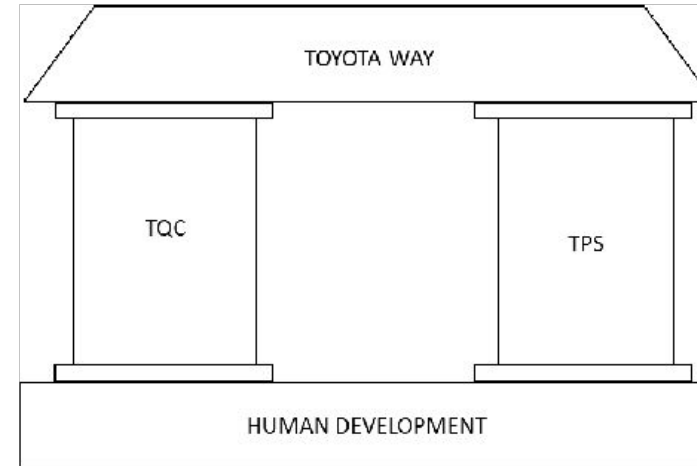
46.9
37.3
75.4
159.6

Enterprise-wide TAKT

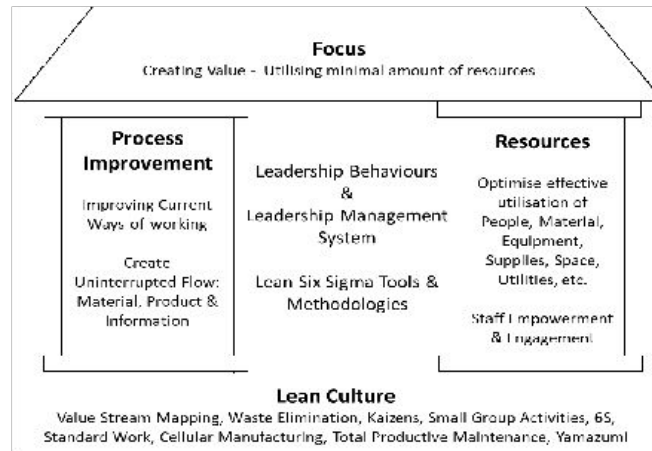




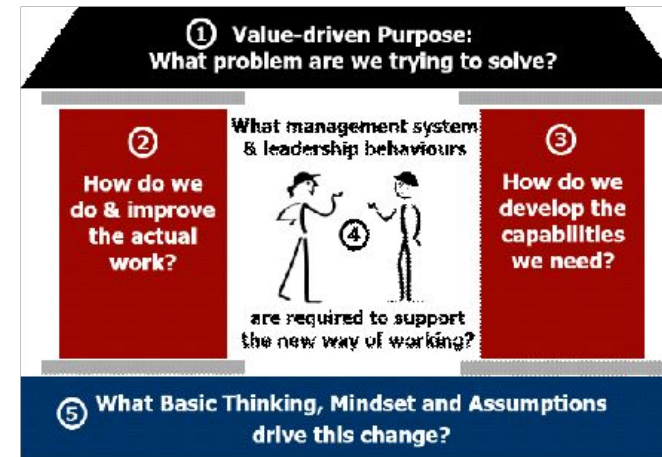
Model of the Toyota Production System (Liker, 2020)



The Toyota House: Six Sigma and Lean (Koenigsaecker, 2012)



Lean Transformation Model (Kelly, 2019)



Lean Transformation Model (Kelly, 2019)

Koenigsaecker (2012) states that over the first four years, LT follows a regular cultural transformation pace.

- **Year one:** Lean is new. Hands-on learning & poor follow-up may slow progress in the first year. Less than 20% used Lean work, making victory unlikely.
- **Year two:** *Change Agents* may resist due to inexperience & mistakes. By year two, most of the organisation lacks Lean learning experience.
- **Year three:** Consolidation as managers & full-time Lean resources learn the process. Quality, lead times, and productivity/cost will compound by the third year, proving the process's success.
- **Year four:** "Change" becomes the norm & continuous improvement becomes institutionalised. This creates a culture that improves forever.

Phase	Specific Steps	Time frame
Get started	Find a Change Agent	0-6 months (Half-a-year)
	Get Lean knowledge	
	Find a lever for change	
	Map Value Stream	
	Begin Kaibutsu (Staged Improvement)	
Create a new organisation	Expand scope	6-24 months (Six months through year two)
	Re-organise business by product family	
	Create lean function	
	Devise a policy for excess people	
	Devise a growth strategy	
Install business systems	Remove anchor-draggers	24-48 months (Years three and four)
	Instill a "perfection" mindset	
	Introduce lean accounting	
	Relate pay to firm performance	
	Implement transparency	
Complete the transformation	Initiate policy deployment	By end of year five
	Introduce lean learning	
	Find right-sized Lean tools	
	Apply these steps to your suppliers / customers	
	Develop global strategy	
	Transition from top-down to bottom-up improvement	

Source: **Womack & Jones** (2003) "Lean thinking: Banish waste and create wealth in your corporation"

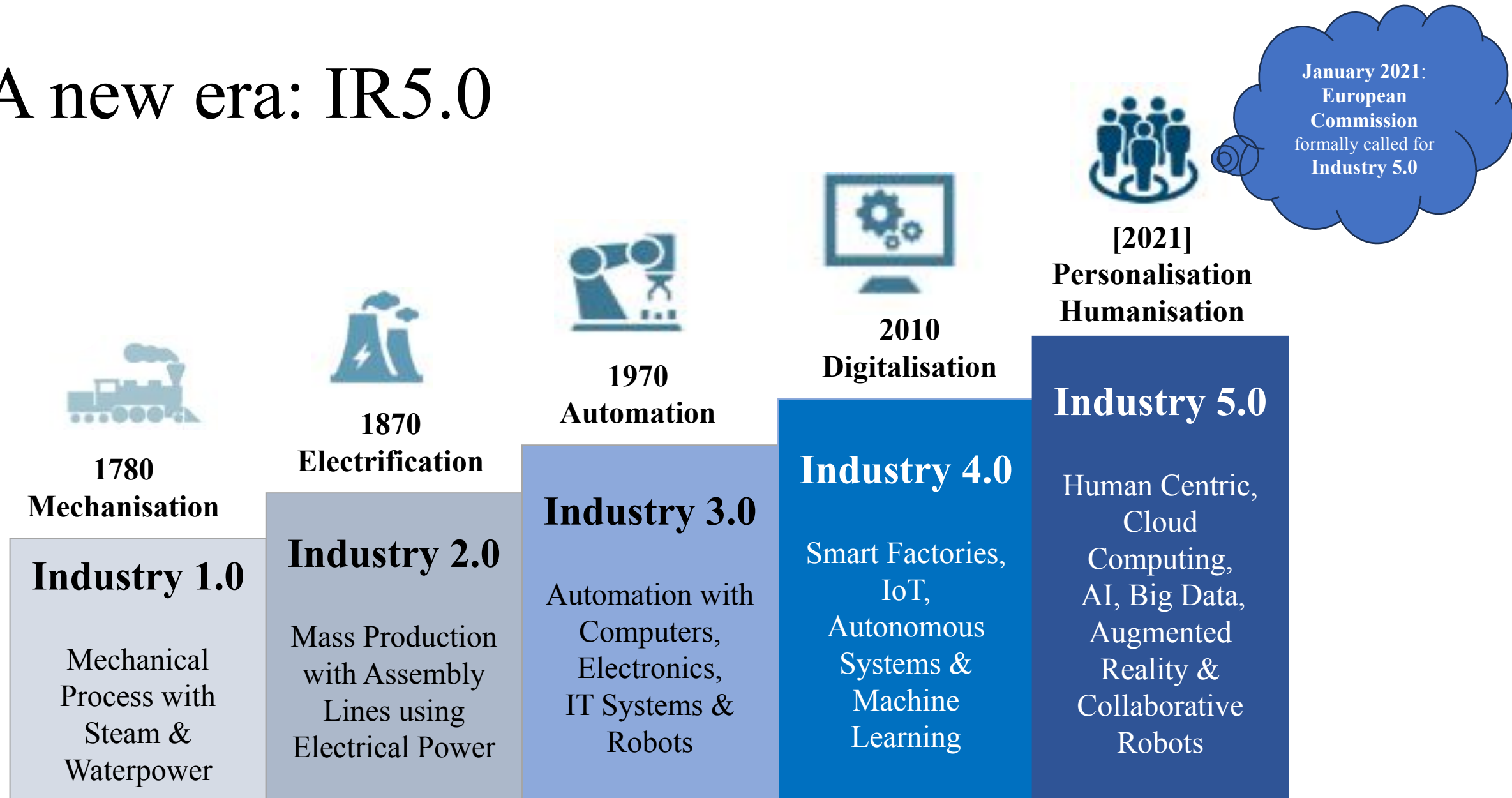
Pragmatic Ambiguity

- **Dorval** et al.'s (2019) meta-analysis: First systematic literature review on lean culture using a broad and inductive approach.
- **1,066 references** (*678 academic papers, 121 books, 103 PhD Theses and 164 commercial documents*) found 13 definitions of lean culture
- Concept of “lean culture is in a state of **pragmatic ambiguity (PA)**, allowing **multiple interpretations of the same concept** leading to different applications.”
- PA allows **concepts like lean and its culture to survive and thrive for a while**, but it can only last for so long before **flaws and inconsistencies are exposed**, leading to confusion and interest waiving (Dorval, et al., 2019).

Research Objectives

- Human-Centricity
- TOC for Adoption
- LT for Diffusion

A new era: IR5.0



Source: *Antoinette Hodes, Check Point Solutions Architect EMEA, Office of the CTO.*

<https://www.cybertalk.org/2022/12/16/bringing-back-the-human-in-technology-with-industry-5-0/>

Human-Centricity: A business imperative

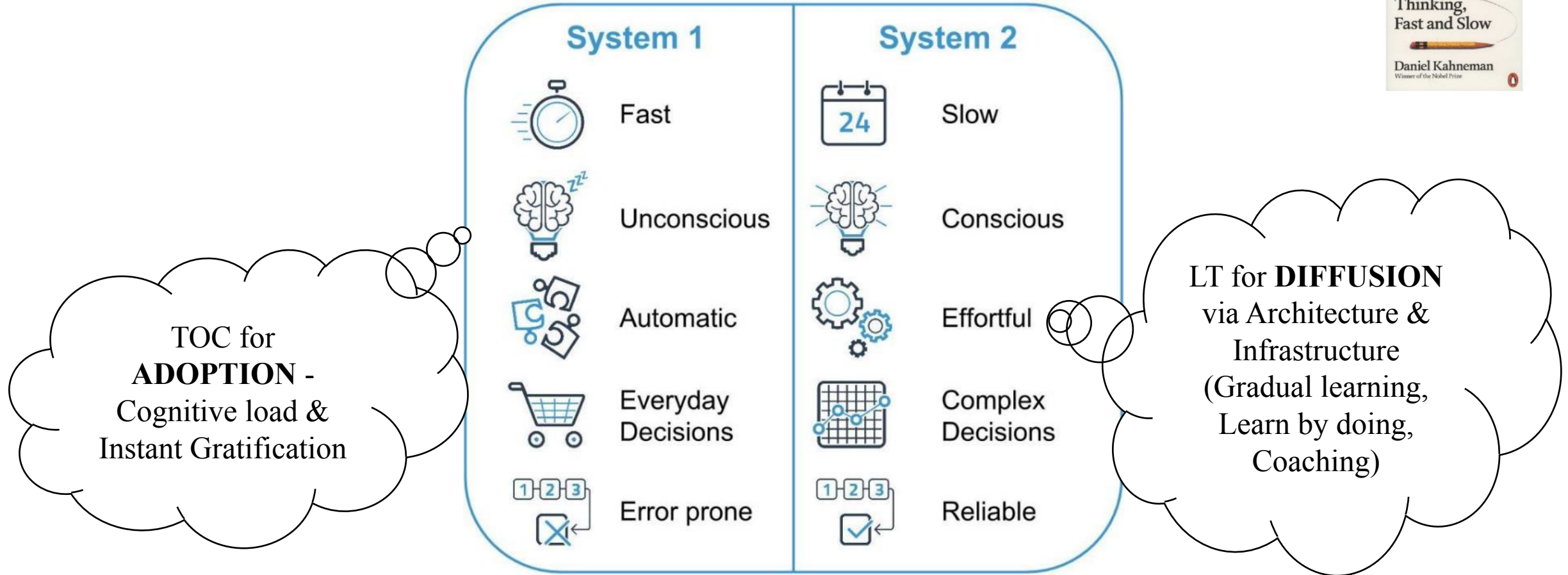
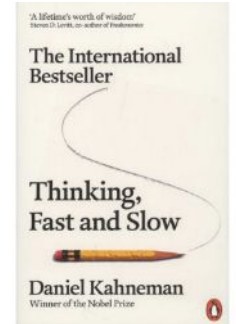
“Untapped reservoirs of human potential” [*Coaching for Performance*, Whitmore]

- Productivity: 38% vs 220% due to behaviour
- Bottom-line benefit: Average 800% ROI

Multiplying Genius [Multipliers, Liz Wisemen]

- Genius Diminishers: ‘High ROI on Politics’
 - Poor leadership turns ‘enthusiasts into laggards’; ‘Outwardly submissive, inwardly rebellious’
 - Psychosocial Burden – Dr. Chigwada
- Accidental diminishers
- Genius Multipliers

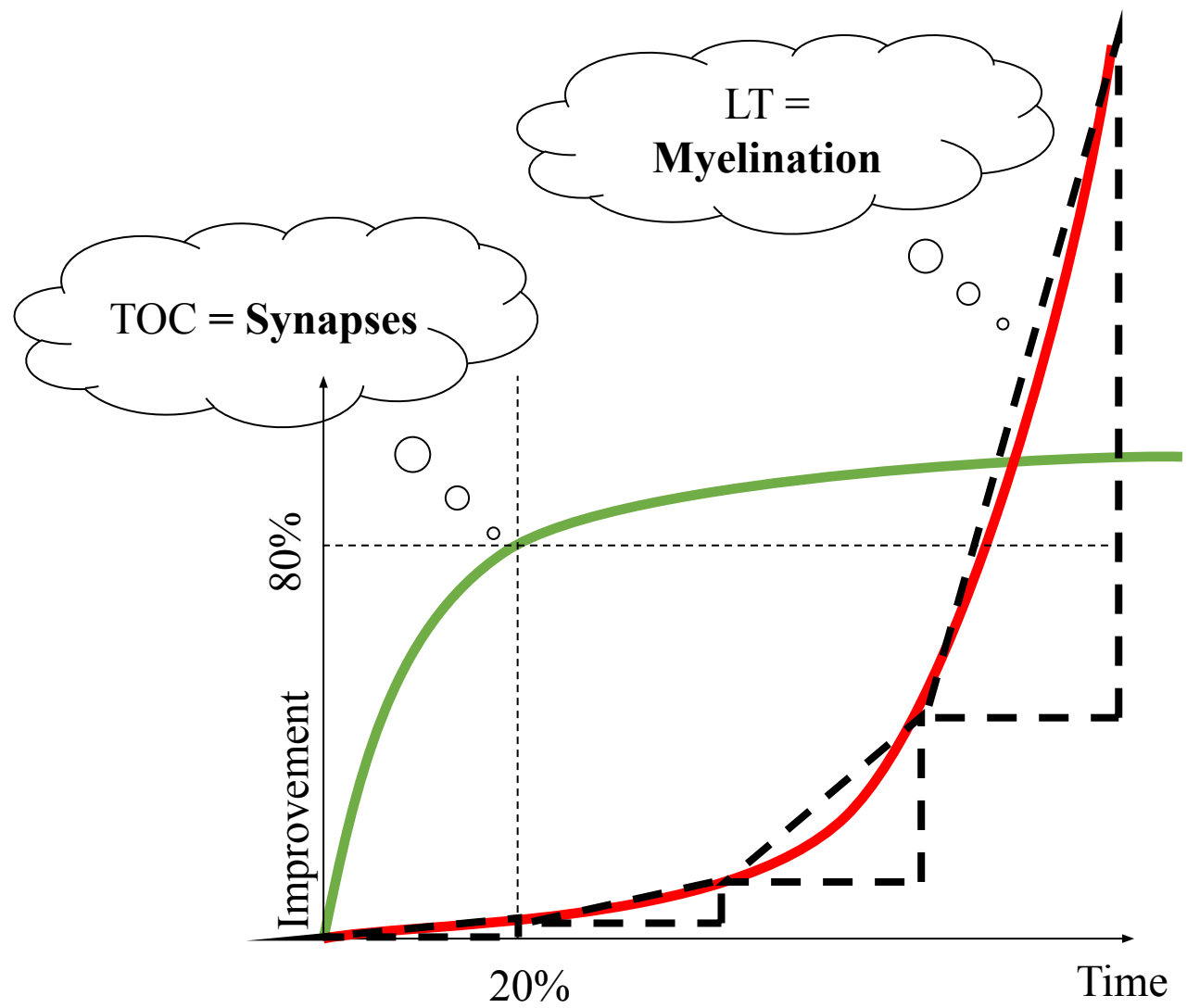
Behaviour: External Observation



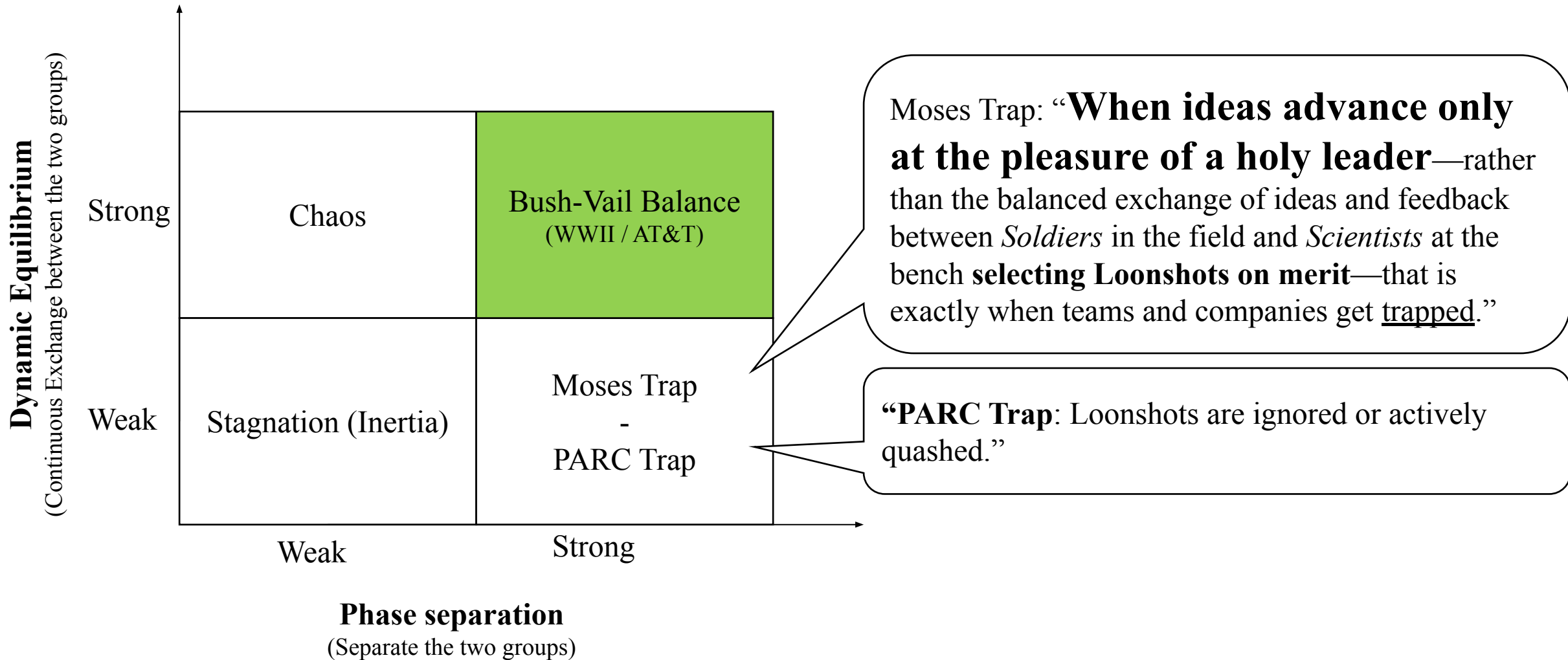
(Source: researchgate.net)

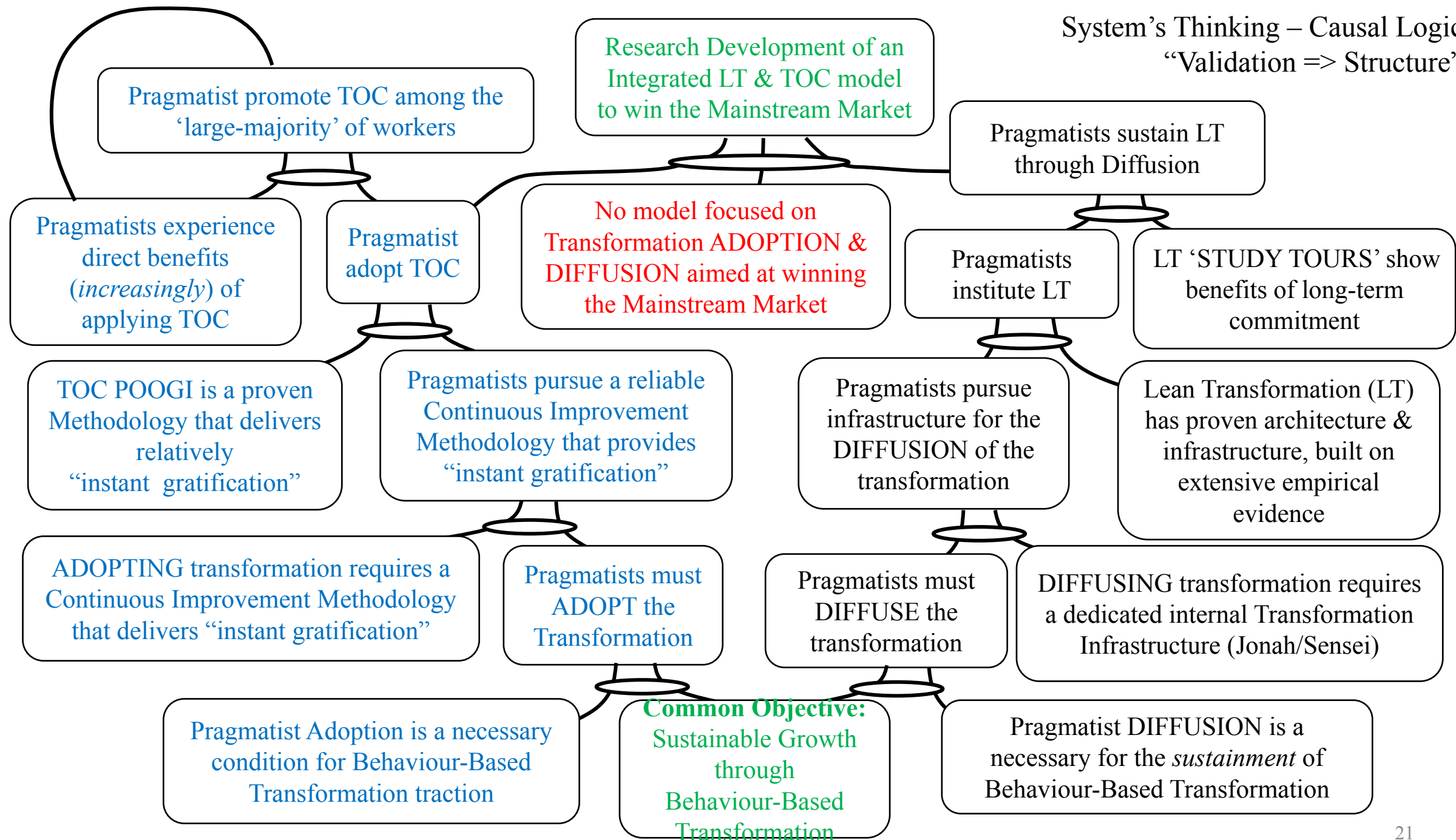
Neuroplasticity: Behaviour Internal Mechanics

Cell body-Axons-Synapses-Dendrites-Neurons

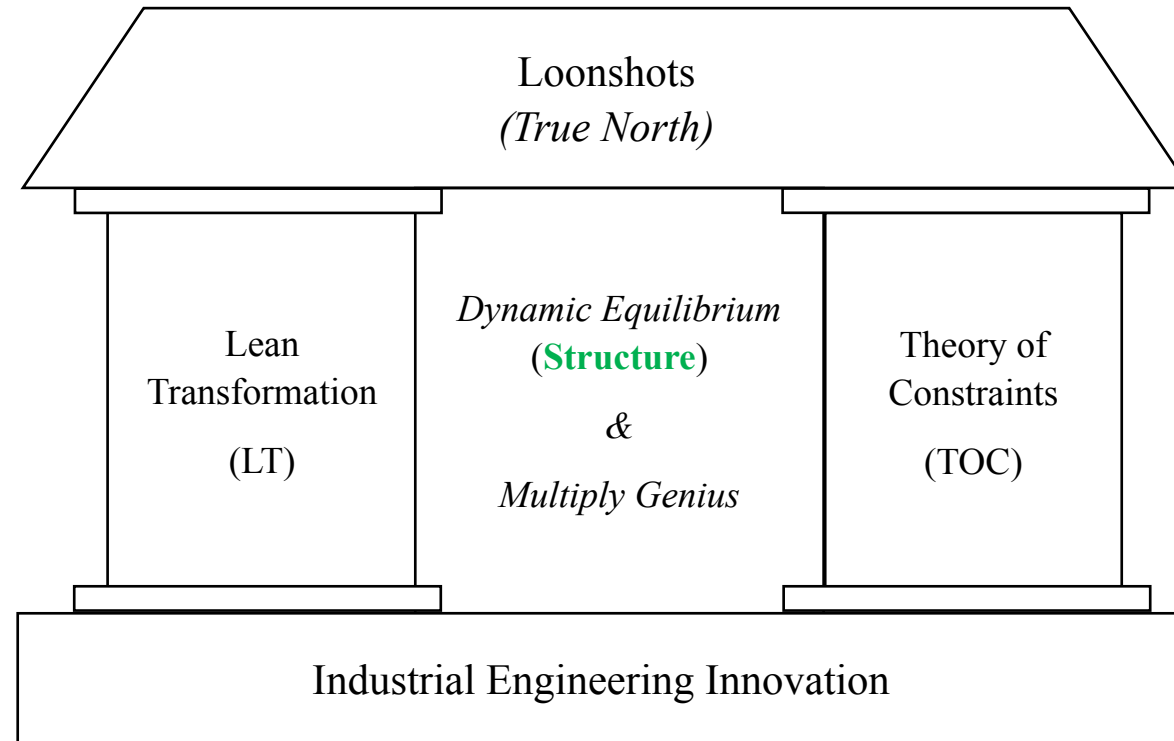


Structure vis-à-vis Culture





Proposed Integrated LT-TOC Model



Delphi Validation

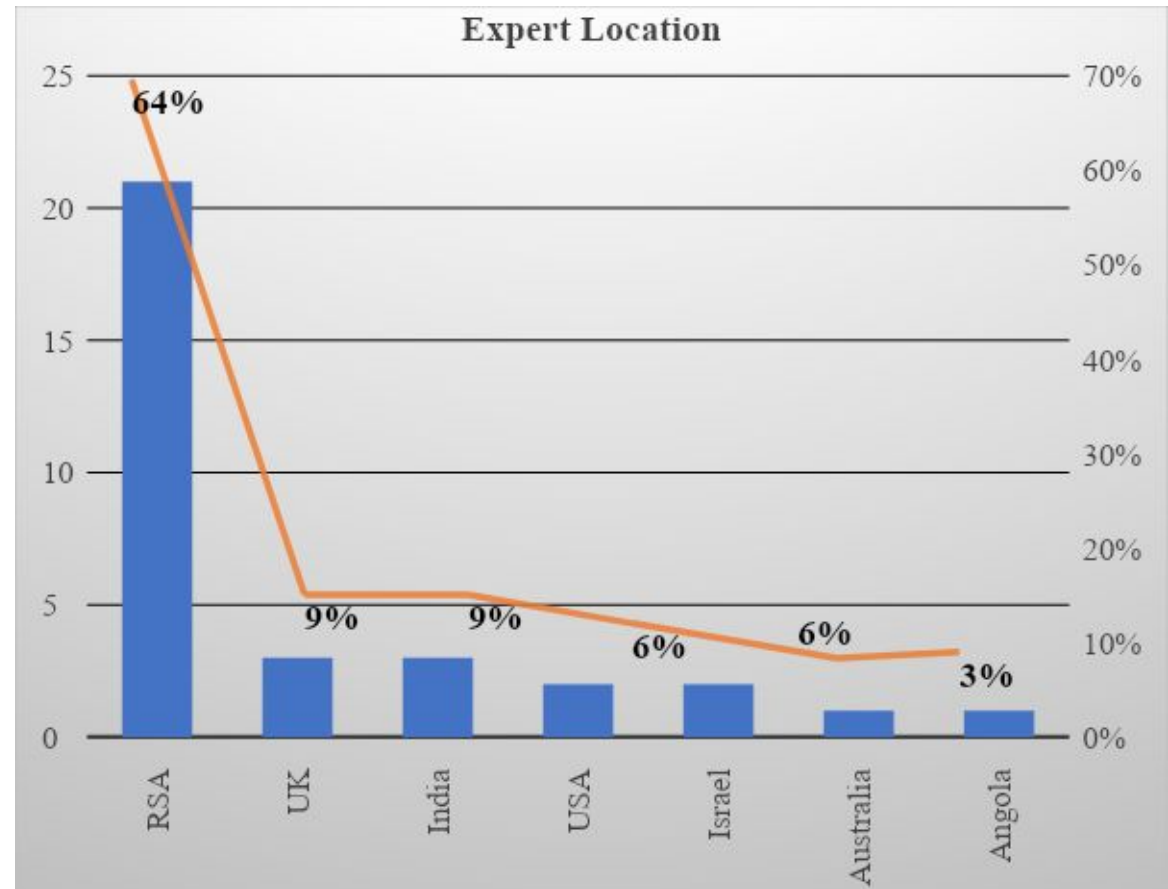
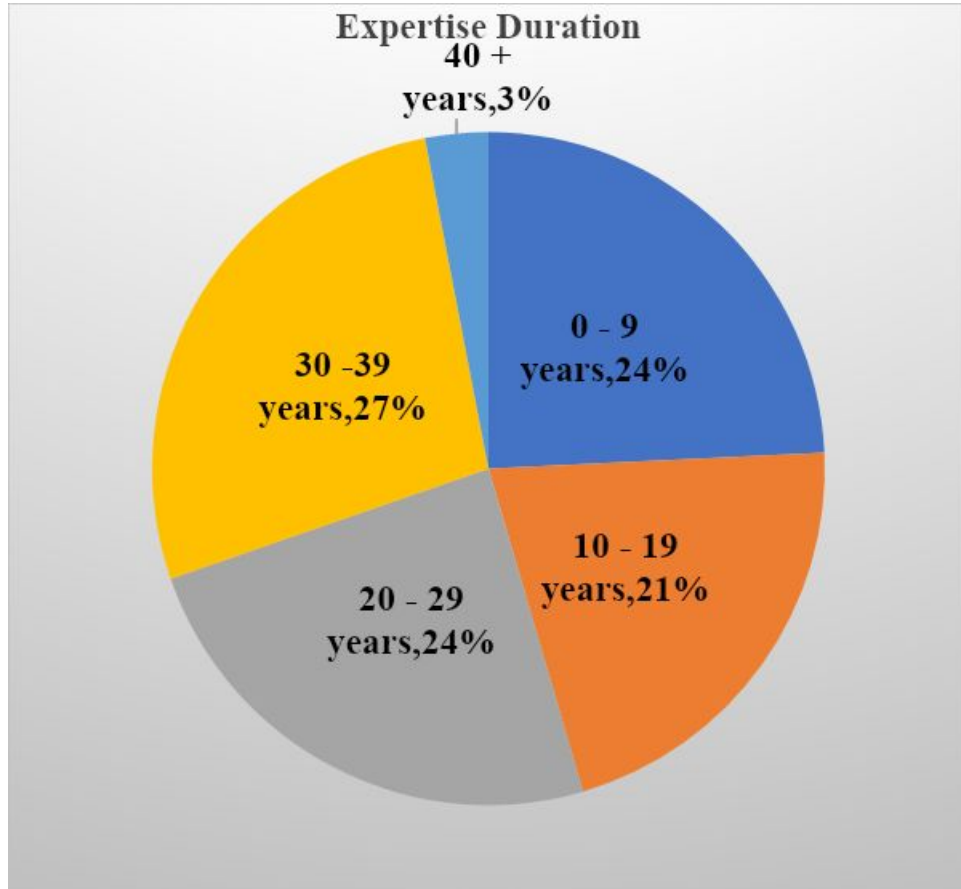
- Quantitative Consensus
- Qualitative Thematic Analysis

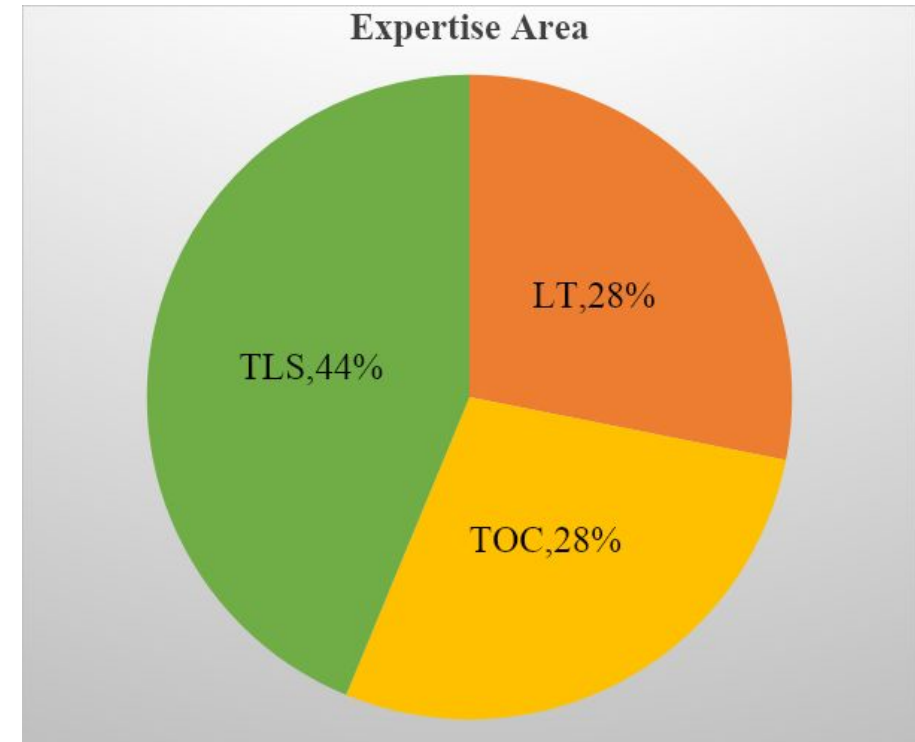
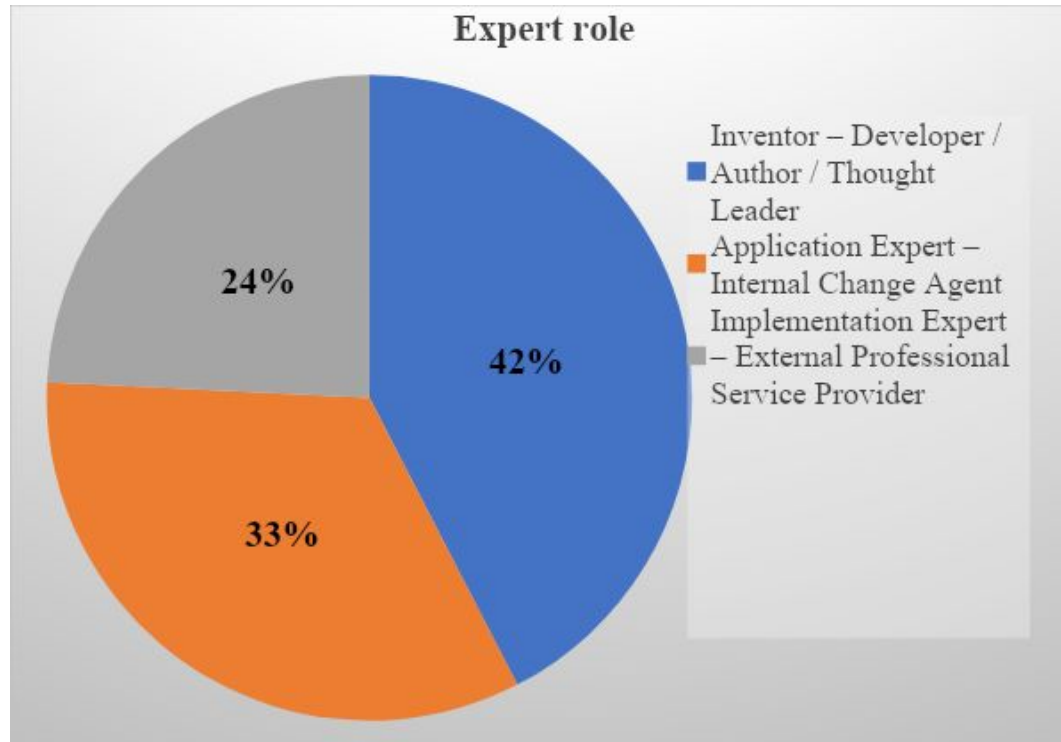
Delphi Study - 33 global expert panellists over 17 months

ID No.	Expertise	Location	Interview Date	LT / TOC / TLS	Innovation Experience (Years)
1	Inventor	USA	12 June 2024	TLS	30
2	Application	RSA	13 June 2024	LT	4
3	Application	RSA	03 July 2024	TOC	17
4	Inventor	RSA	04 July 2024	TOC	30
5	Implementation	UK	12 August 2024	LT	39
6	Implementation	RSA	12 August 2024	TLS	20
7	Implementation	Australia	13 August 2024	TOC	14
8	Inventor	Israel	14 August 2024	TOC	42
9	Implementation	UK	14 August 2024	LT	25
10	Implementation	RSA	14 August 2024	LT	10
11	Implementation	RSA	16 August 2024	TLS	20
12	Inventor	Israel	21 August 2024	TOC	30
13	Implementation	India	21 August 2024	TOC	24
14	Application	RSA	02 September 2024	TLS	14
15	Application	RSA	16 September 2024	TLS	25

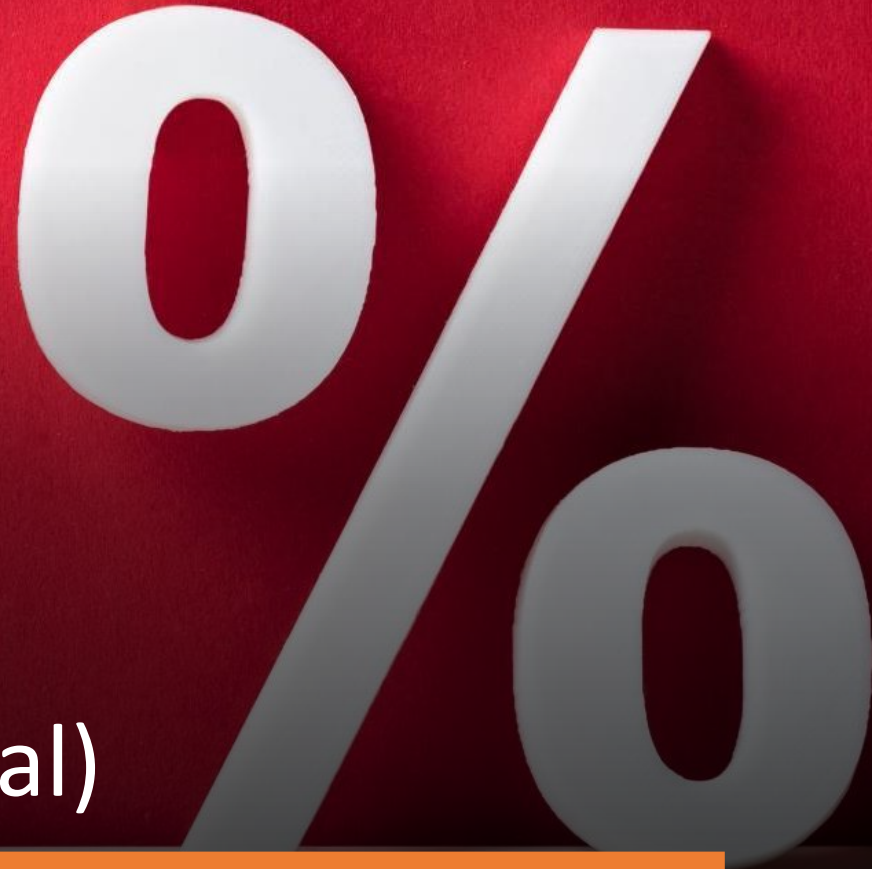
Aim: to evaluate the model's coherence & practicality

16	Implementation	RSA	18 September 2024	TLS	30
17	Implementation	RSA	19 September 2024	TOC	20
18	Implementation	RSA	19 September 2024	TLS	10
19	Application	Angola	20 September 2024	TLS	23
20	Application	RSA	25 September 2024	TOC	30
21	Application	RSA	15 October 2024	LT	30
22	Application	RSA	18 October 2024	TOC	10
23	Application	RSA	22 October 2024	TLS	10
24	Inventor	USA	23 October 2024	TLS	30
25	Inventor	India	12 November 2024	TLS	30
26	Inventor	UK	24 February 2025	Lean	25
27	Implementation	RSA	04 March 2025	Lean	6
28	Application	RSA	12 March 2025	LT	6
29	Application	RSA	22 April 2025	LT	6
30	Inventor	RSA	17 April 2025	TLS	6
31	Application	RSA	11 June 2025	Lean	6
32	Application	RSA	05 November 2025	TLS	6
33	Application	RSA	09 November 2025	TLS	6





96% agreement
Quantitative validation
(Model = Coherent & Practical)



Thematic analysis identified six interlocking themes

Theme	Consensus	Divergence	Implication
Complementarity & Integration	LT & TOC are complementary—TOC delivers quick adoption via rapid results; LT provides foundations for sustainment.	Sequencing: TOC-first (momentum) vs. Lean-first (avoid superficial gains).	Adopt a hybrid, phased approach: TOC catalyses adoption; Lean embeds long-term change.

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Human-Centricity & Systems Thinking	Human-centric leadership, cultural alignment, and systems thinking are essential.	Balance of structure vs. flexibility; Emphasis on coaching vs. systems design.	Leaders must multiply capabilities while aligning culture across functions.

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Pragmatic Ambiguity & Adoption Challenges	LT's pragmatic ambiguity is a challenge; TOC brings clarity via focus on the constraint.	LT's flexibility: strength (tailoring) vs. weakness (adoption risk).	- Combine TOC's clarity with LT's cultural infrastructure; Empower internal champions.

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Quick Wins vs. Long-Term Sustainability	TOC delivers immediate results; LT sustains and scales them.	Risk of TOC gains collapsing without LT; some believe quick wins naturally foster adoption .	Sequence TOC for momentum, then Lean Transformation for sustainment.

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Quick Wins vs. Long-Term Sustainability	TOC delivers immediate results; LT sustains and scales them.	Risk of TOC gains collapsing without LT; some believe quick wins naturally foster adoption .	Sequence TOC for momentum, then Lean Transformation for sustainment.
Cultural & Paradigm Shifts	Shift from reductionist (ROI-first) to people-first systems thinking, is necessary.	Pace: rapid , top-driven vs. gradual , organic change.	Nurture culture as carefully as technical change; commit long-term; use early wins to build buy-in.

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Validation & Empirical Testing	Empirical Verification is necessary.	Implement now vs. Pilot extensively.	Continuous testing & adaptation to ensure real-world credibility.

Conclusion

Integrated LT–TOC Model is **validated** by a 96% consensus among global experts (primary statement +96.7%), confirming **theoretical coherence & practical relevance**.

The **model operationalizes Covey's 3rd Alternative approach**: employ TOC to secure early, visible results that cross the adoption chasm, then Lean Transformation to institutionalize those gains through structure (culture), capability & standardization.

Thank you

Questions?

Kantianism

- “Right thing to do is to perform your duty (‘categorical imperative’) for duty’s sake (deontological approach)
- Always treat **people as having inherent moral value (or dignity)** & not as objects to be used to achieve some end.
- Like ideas of *Ubuntu*”

Utilitarianism

- “Right thing to do is to produce the greatest balance of good/bad consequences for the greatest number of people.
- ‘**Good**’ = happiness, preference or other desirable outcomes
- Outcome is important”