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New Product Development as a Complex Adaptive System of Decisions

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With:

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MY BACKGROUND

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OVERVIEW

- A review of new product development (NPD) frameworks:
  - Linear
  - Recursive
  - Chaotic

- A complex adaptive system (CAS) view of NPD:
  - CAS phenomena
  - System dimensions
  - Decision levels
- Case studies
- Discussion questions, implication and conclusions.

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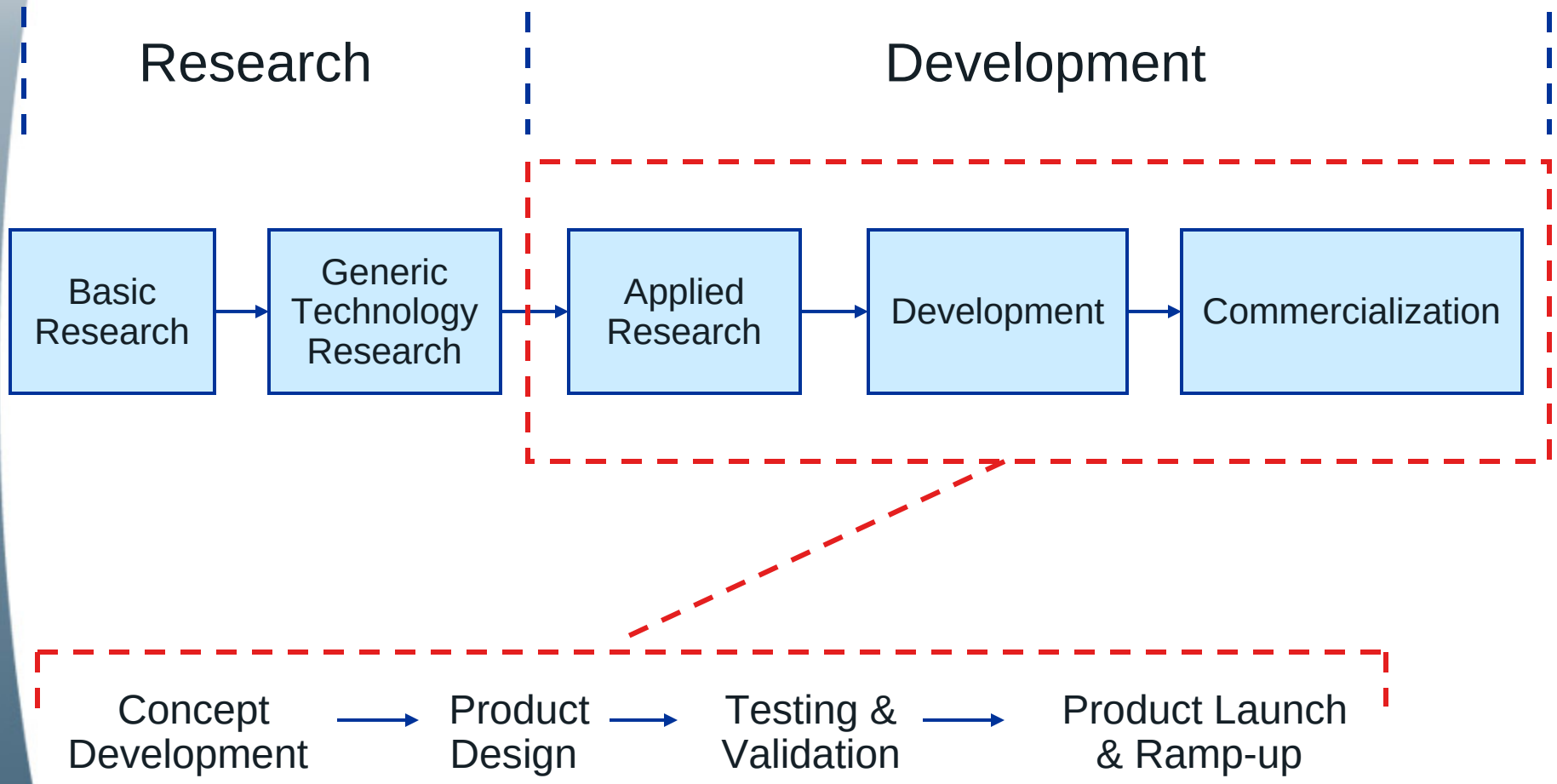
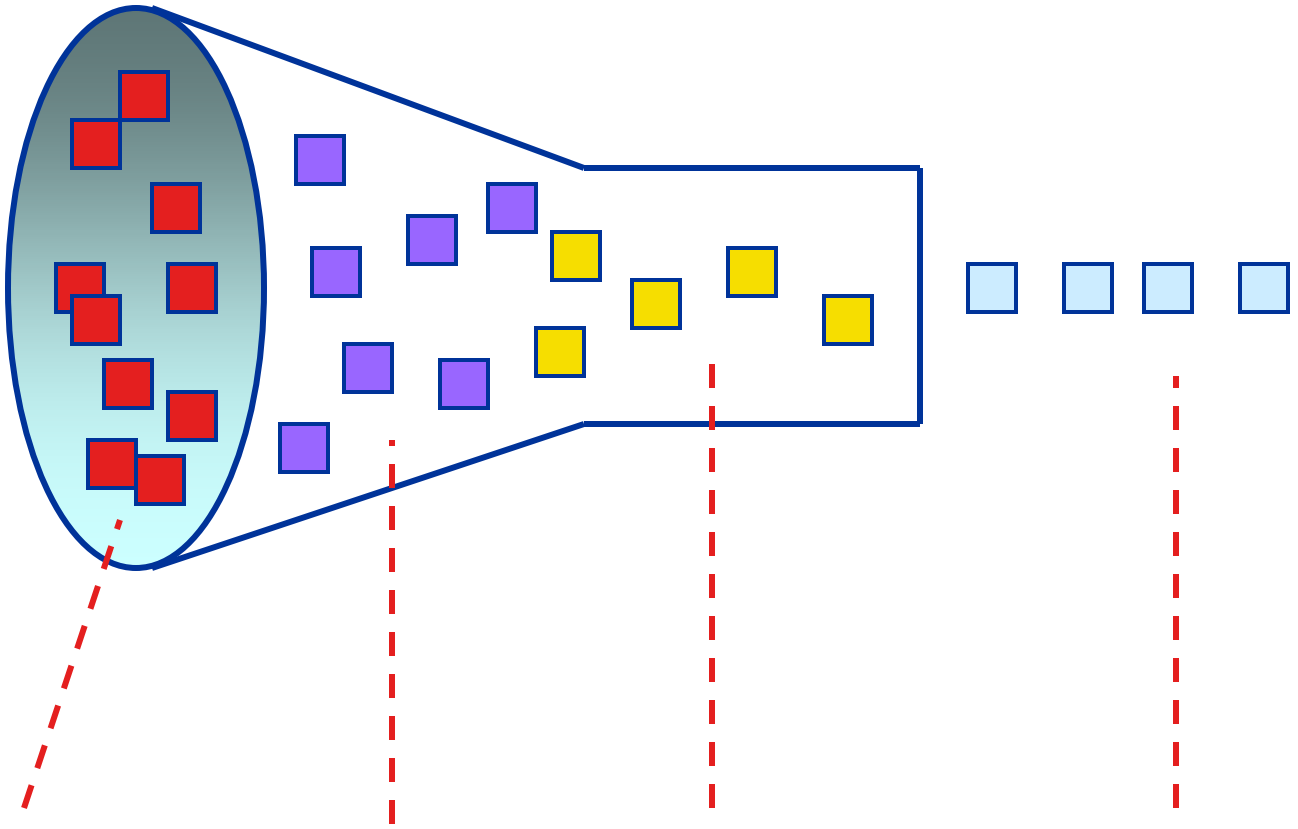
NEW PRODUCT DEVELOPMENT



THE DEVELOPMENT FUNNEL



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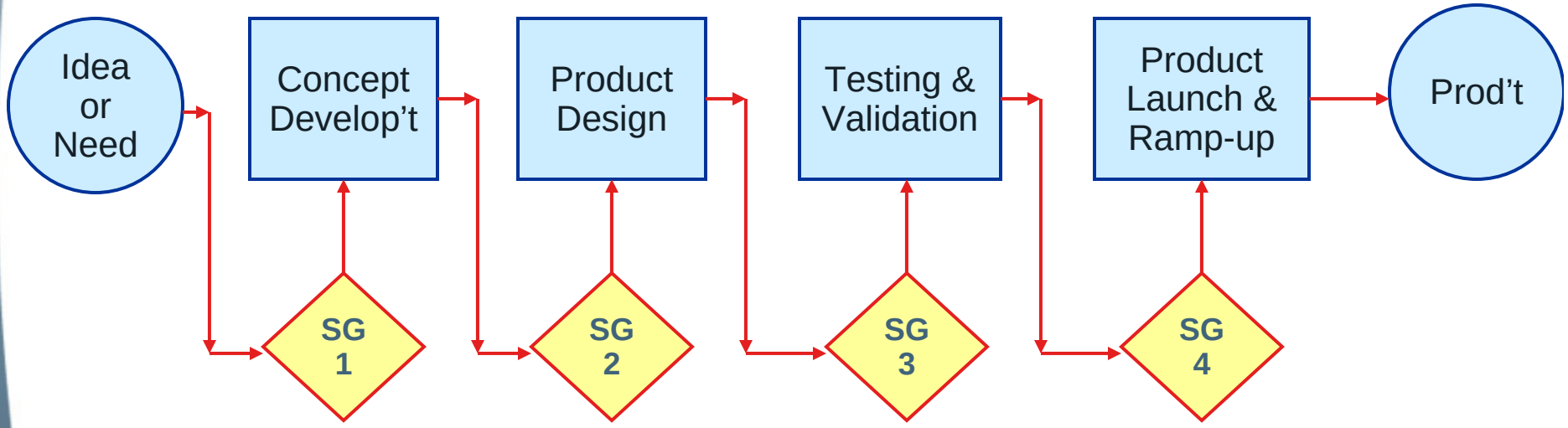
LINEAR FRAMEWORKS

The Stage Gate Process (Cooper, 1990)



LINEAR FRAMEWORKS

- A process with relatively fixed, discrete and sequential stages.
- The connections, flows and outcomes of the process are comparatively deterministic.
- Simple and effective representations of the structural logic and flows.
- Suited to incremental innovation activity with relatively reliable market push or strong market pull forces.

- Does not consider the dynamic behaviors and relationships associated with agency, freedom and resulting innovations.

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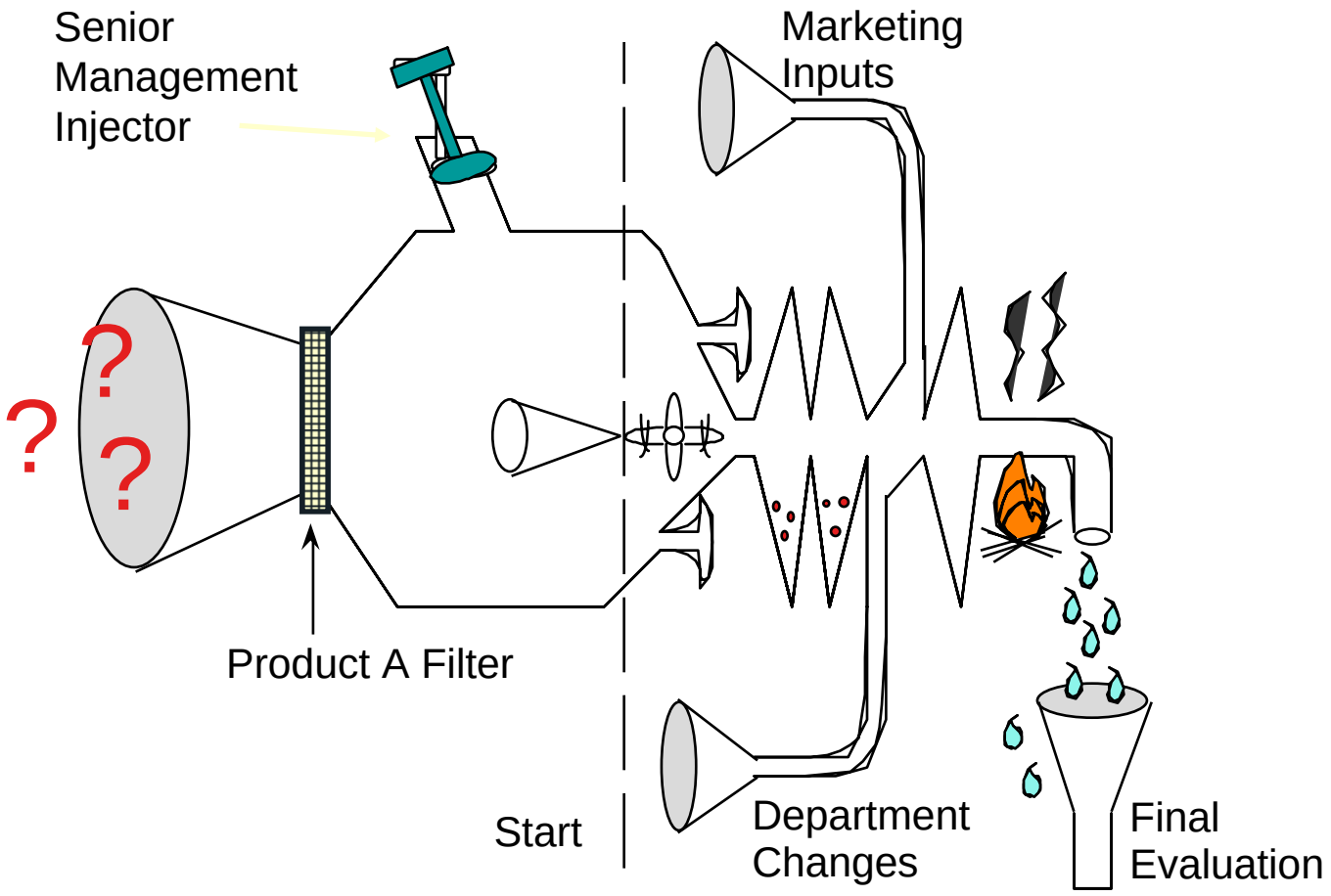
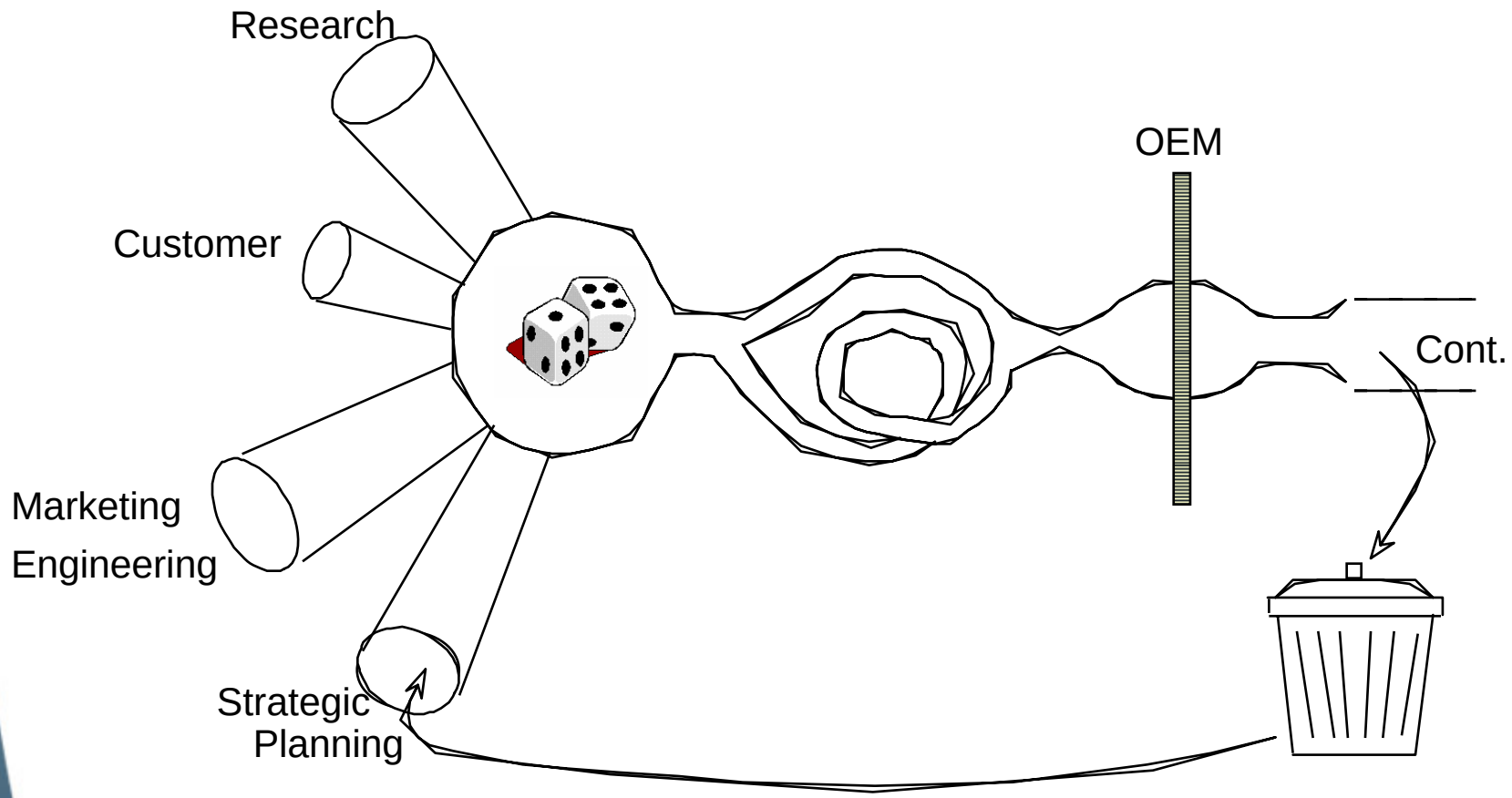
FUNNEL REALITY – TYPE 1



Adapted from MacCormack 2001

FUNNEL REALITY – TYPE 2



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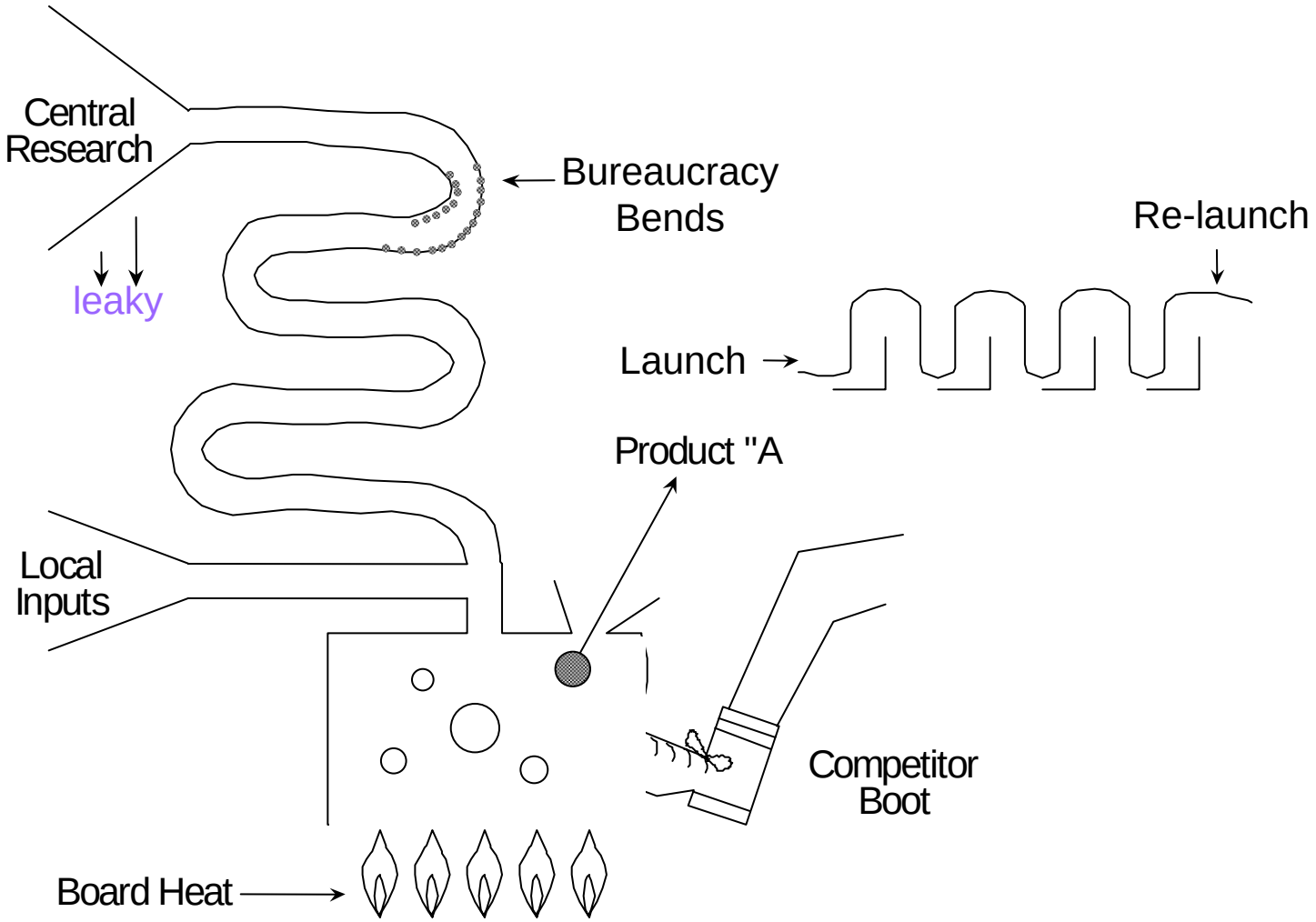
FUNNEL REALITY – TYPE 3



Adapted from MacCormack 2001

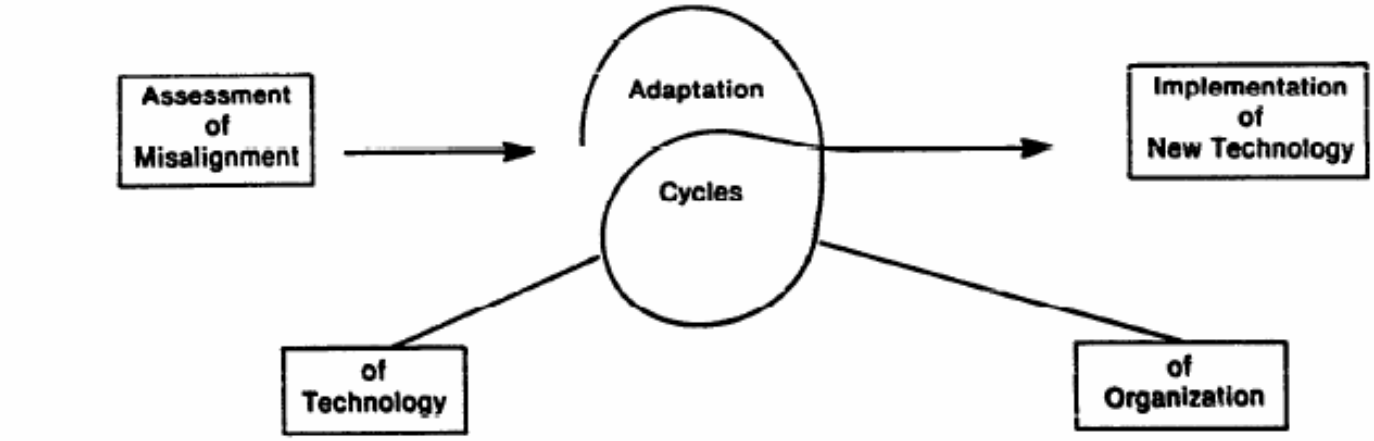
RECURSIVE FRAMEWORKS

- Kline and Rosenberg (1986) “chain-linked model” – relationships between stages described in terms of feedback loops and iterations.

- Leonard-Barton (1988) “adaptation cycles” - NPD as a series of small and large recursive cycles that represent project set backs and restarts.

- Schroeder et al.'s (1989) 'big bang' theory of innovation.

RECURSIVE FRAMEWORKS



	Detrimental	Beneficial
Large Cycle:	Cancellation (No learning captured) [Solagen]	Failure Forward (Learning captured) [XCON]
Small Cycle:	Truncation (Loss of functionality) [Polymer—at first]	Adaptation (Creation of value) [Copper]

Detrimental	Beneficial
Grid-lock (Inconsistency in performance criteria or delivery systems; or severe mistiming of adaptation) [XSEL—at first]	Strategic Shift (Change in performance criteria at high level; integration of delivery systems) [MRPII]
Accretion (Additional performance criteria; overlay of systems in delivery system without redesign [J.R Circulator]	Job/Task Redesign (Change in performance criteria; alteration of delivery systems) [XSEL—eventually]

Leonard-Barton 1988

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RECURSIVE FRAMEWORKS

- A process with concurrent and multiple feedback loops between stages that generate iterative behavior and outcomes that are more difficult to predict.
- Represents the dynamic and fluid nature of the process.
- Suited to more radical innovations with push-pull market force combinations.

- Assumes similar behavior across the whole process and does not represent the structural and behavioral instabilities of the process.

CHAOTIC FRAMEWORKS

- Cheng and Van de Ven (1996) used a chaos theory algorithm from physics to examine the effects of feedback loops in NPD.

- Koput (1997) also used a chaotic framework, but was concerned with the dynamics of searching for innovation.

- Kim and Wilemon (2002) the “fuzzy front end”

CHAOTIC FRAMEWORKS

Variables:

ES=External Stocks

II=Incoming Ideas

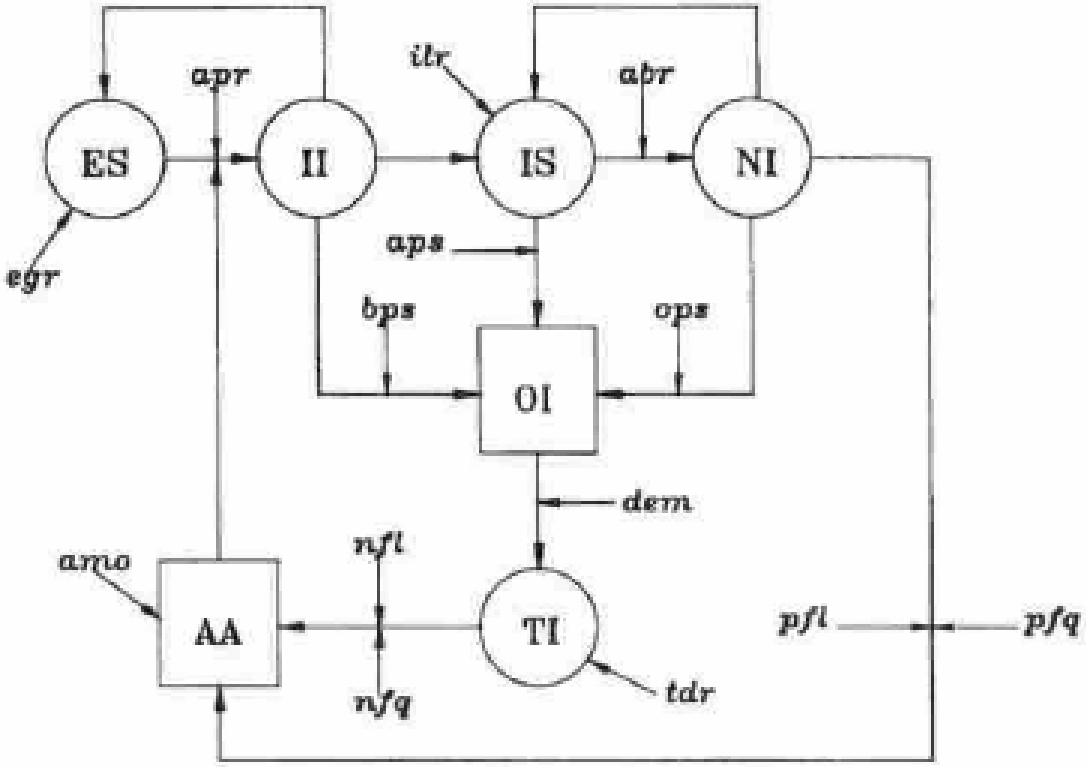
IS=Internal Stocks

NI=New Ideas

OI=Organizational Ideas

TI=Testing Ideas

AA=Allocation of Attention



Koput (1997)

CHAOTIC FRAMEWORKS

- A process where the linkages and flows are greater during the initial stages, resulting in different degrees of feedback across the process.
- The initial stages exhibit chaotic dynamics and outcomes that appear to be random and unpredictable, while the latter stages are relatively stable and certain.
- Suited to the search and exploration aspects of very radical innovations or ‘really new products’.

- Focuses on differences between the stages and presupposes that the overall process configuration is fixed i.e. does not consider process adaptability.

NPD AS A CAS OF DECISIONS

- NPD process connections and interactions produce:
  - Non-linearity
  - Self-organization
  - Emergence

- Schoderbek et al. (1985) system dimensions:
  1. number of elements that make up the system
  2. attributes of the elements
  3. number and type of interactions among the elements
  4. degree of organization inherent in the system

- NPD agents make judgments and choices that bridge the gap between an idea and reality:
  1. Strategic decisions,
  2. Review decisions,
  3. In-stage decisions

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WHY CASE STUDIES?

- Macro level studies are *inappropriate* for understanding what goes on inside the “black box”
- Macro studies focus on the stock and flow of inputs and outputs.
- Case studies allow:
  - Insights about the connections, interactions and rules.
  - Observe real time changes in the above.
  - Permits theory building and initial theory testing.

- Three companies that vary according to one or more of Schoderbek’s dimensions.

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THE COMPLEXITY GRID

CASE STUDIES

- Processes typified as linear, organized and controlled and with a tendency to develop products in consultation with their customers.
- Varied in terms of:
  - agents in the process
  - distribution of agents
  - formality, control and documentation
  - rules, structures, procedures and technologies

- A formal and documented NPD process within the organizations.

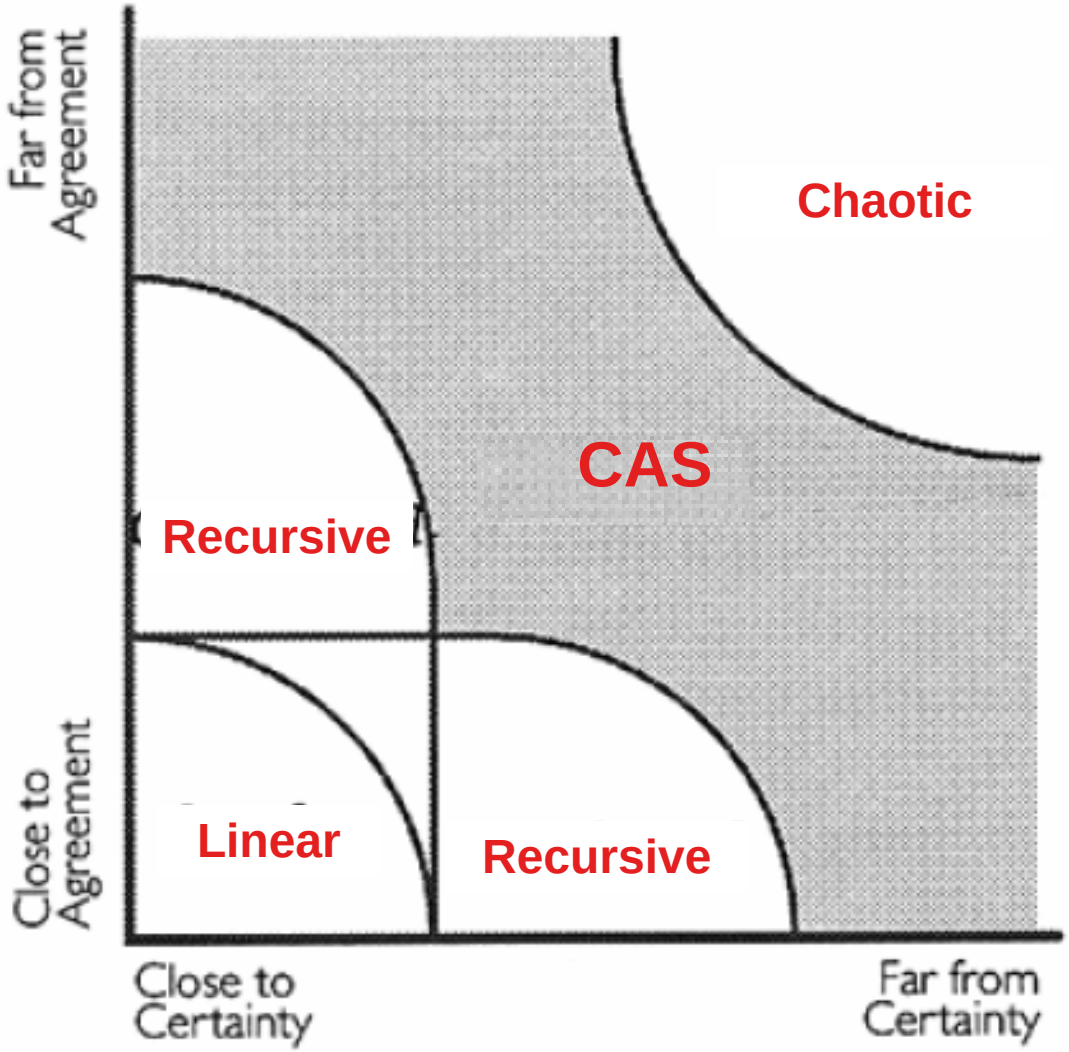
NON-LINEARITY IN NPD

- New team members did not result in a linear increase in progress.
- Exponential expectation change.
- Location and frequency of strategic decisions.
- Frequency and duration of review decisions can dampen non-linearity.
- In-stage decision autonomy constrained by technology and procedures.

SELF-ORGANIZATION AND EMERGENCE IN NPD

- Unplanned and temporary social units.
- “Exploration Days”.
- Rule breaking and fire-fighting.
- “Loose cannon” behavior.
- NPD process adaptability occurred to maintain congruence between process behavior and the demands of the environment.

STACEY'S COMPLEXITY MATRIX



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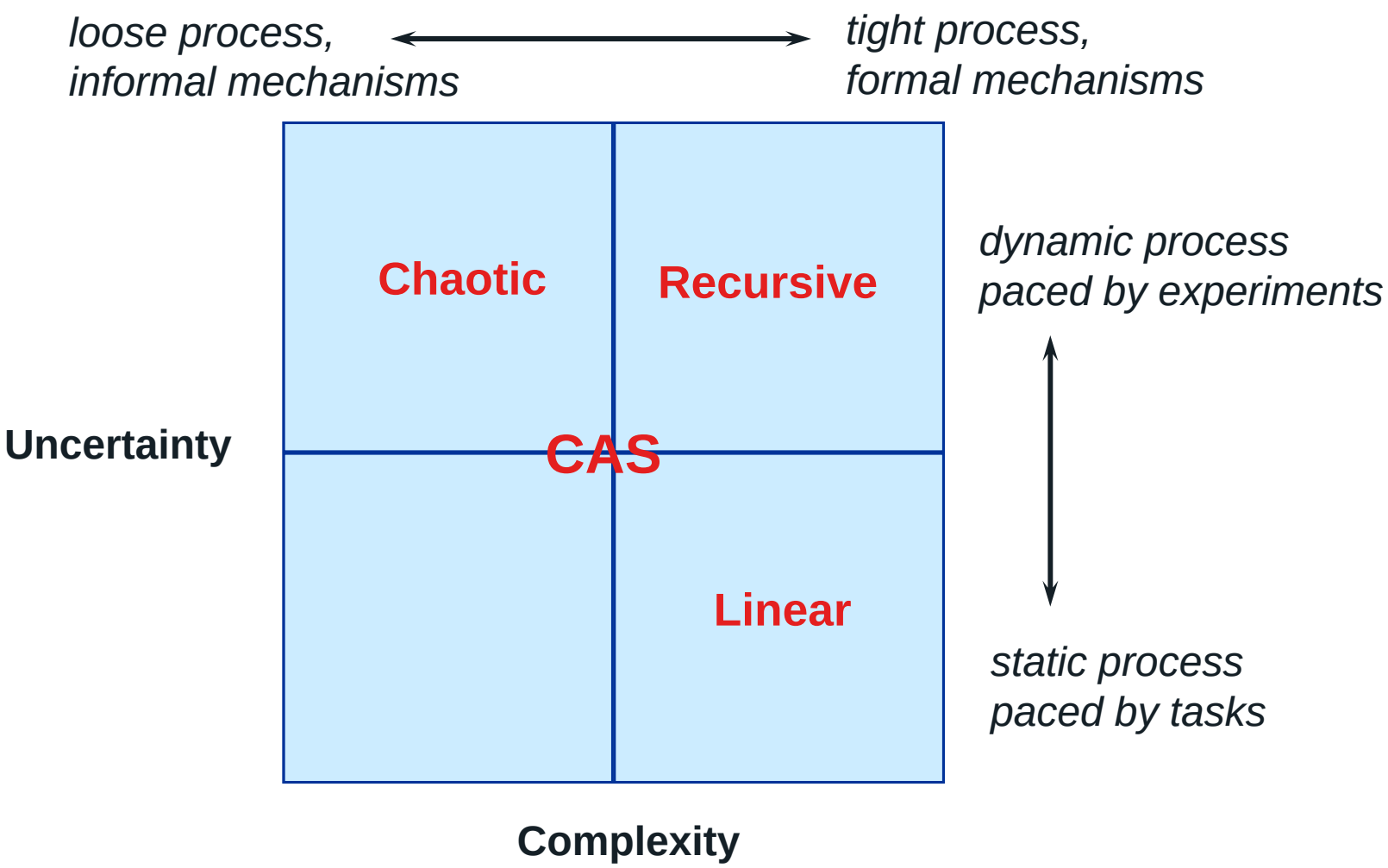
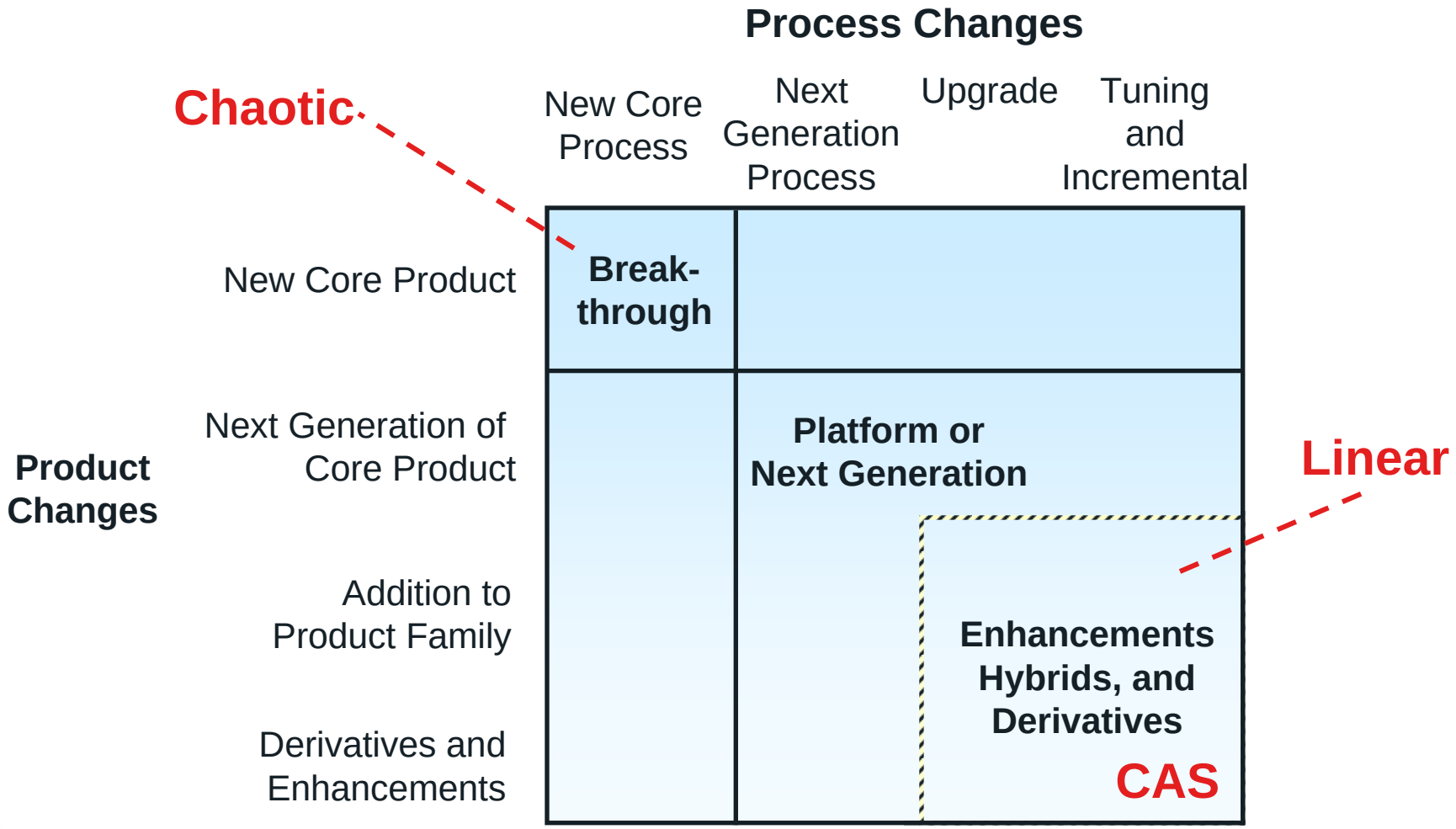
NPD DYNAMICS & COUPLING



INNOVATION TYPES



Adapted from Wheelwright & Clark 1992

FRAMING NPD AS A CAS OF DECISIONS

- Thus, an individual NPD process is able to:

  switch or toggle between system behaviors that range from linear to chaotic, to produce corresponding innovations that range from incremental to radical.

- NPD adaptation is a product of self-organization and emergence, both of which depend on:
  - feedback (positive)
  - some connections and interactions
  - the ability to change or break rules and revise goals
  - slack or redundancy
  - wholeness and diversity

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DISCUSSION QUESTIONS

- How do the four system dimensions determine NPD process adaptability?
- How do the three decision levels affect NPD process adaptability?
- What other contingency factors might influence system framework congruence i.e. when is it best to be linear or chaotic?

1. Number of elements that make up the system
2. Attributes of the elements
3. Number and type of interactions among the elements
4. Degree of organization inherent in the system

1. Strategic
2. Review
3. In-stage

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CONCLUSIONS

- The rate of NPD process adaptability is determined by the rates of change, and levels of stability or disorder imposed on the process. This leads to congruence between the innovative output of the firm's NPD processes (incremental versus radical) and the needs of its environment.

- NPD process adaptability is determined by the number and variety of agents, their corresponding connections and interactions, and the ordering or disordering effect of the process rules and organization.

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CONCLUSIONS

- Strategic and review decisions and their accompanying decision rules, generate order and disorder at the in-stage decision level of NPD. This results in corresponding potentials for process adaptability and matching innovations.

- In-stage decisions and their accompanying decision rules are able to produce enough internal energy to explore and produce self-determined process adaptability.

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CONCLUSIONS

- NPD performance depends on congruence between system behavior:
  - innovation type
  - market dynamics
  - firm dynamics

- Decision levels and rules will determine:
  - How connections are made and broken.
  - Which connections are valuable
  - The resultant system behavior

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CONCLUSIONS & IMPLICATIONS

- Frameworks are complementary steps on an abstraction ladder.

- Contingency – “one framework, does not fit all”

- A CAS framework assumes processes
  - are adaptable
  - can changed to match push or pull market forces and innovation expectations that range from incremental to very radical

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CONCLUSIONS & IMPLICATIONS

- Strategic and review decisions create a top-down management.

- Fear, curiosity, obsession, naughtiness, enthusiasm and anxiety, can produce bottom-up generated process adaptability.

- A CAS view of NPD:
  - Promotes congruence
  - Avoids competency traps

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