Domain-specific Engineering

Reuse-driven Process Improvement (PI_r) – Adopting DsE

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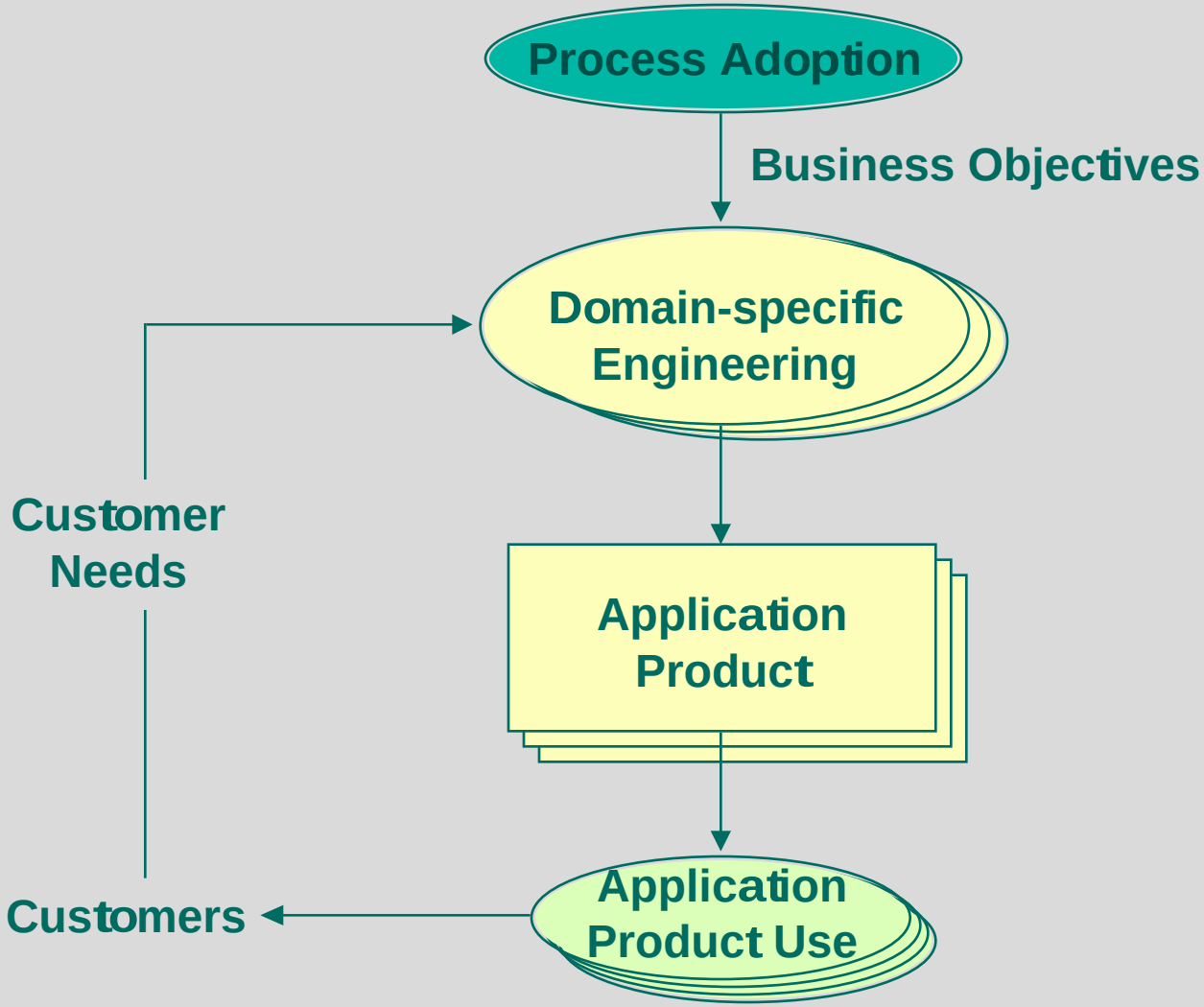
Context for Reuse



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Context for PI_r

A product line market

A process improvement method
(SEI CMM℠, SPICE, BPR, etc.)

A need to improve

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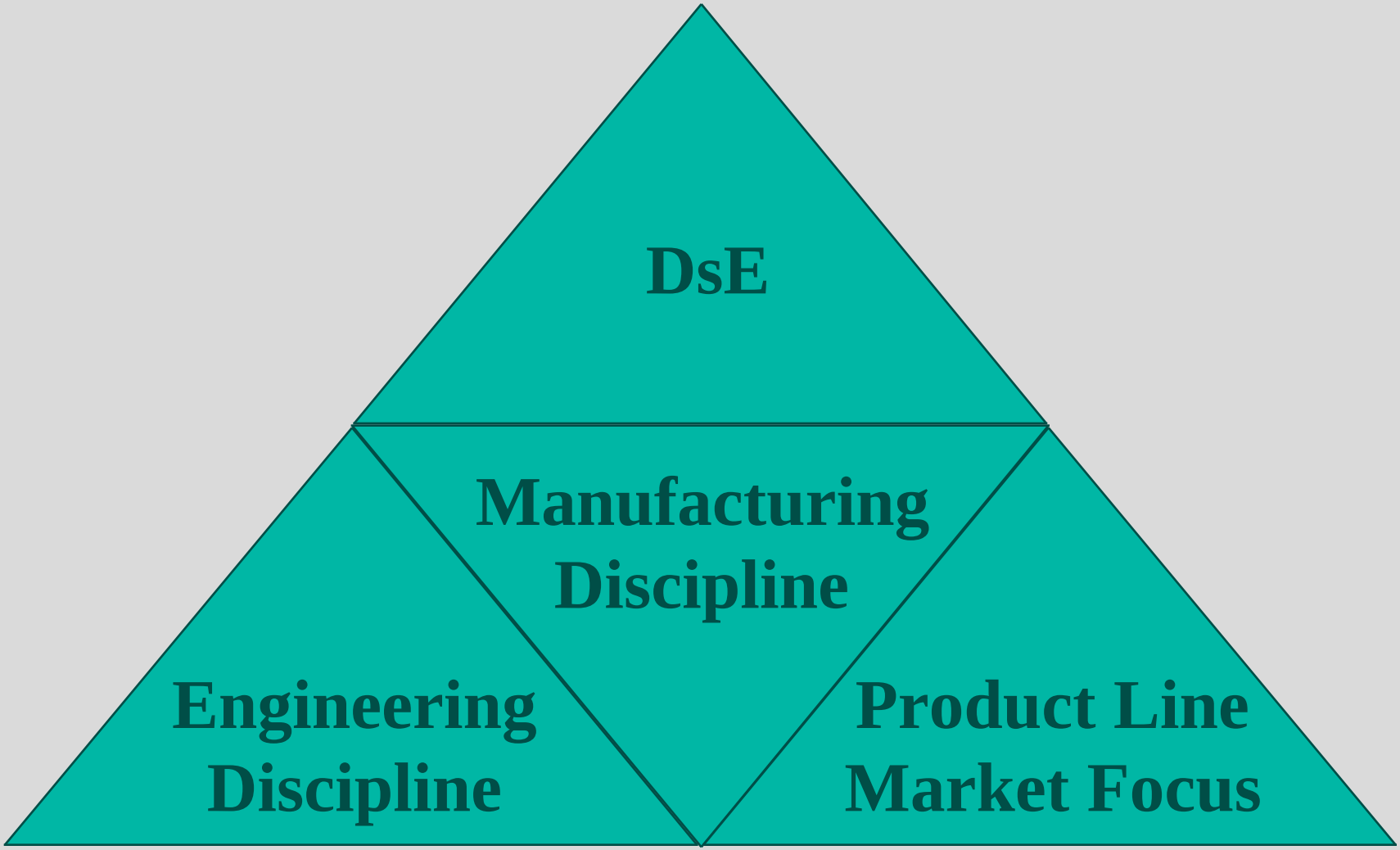
Objectives of PI_r



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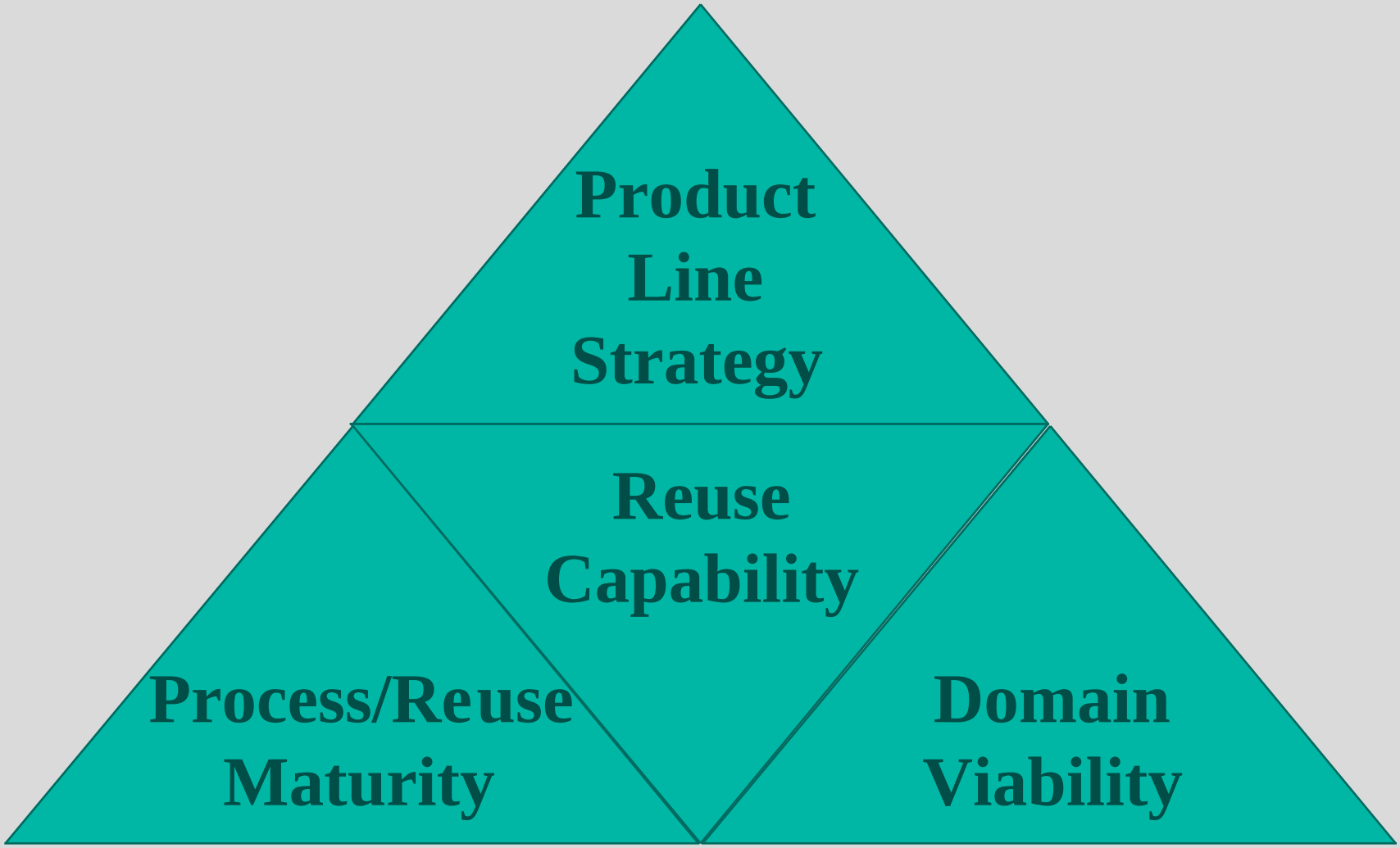
PI_r Tools



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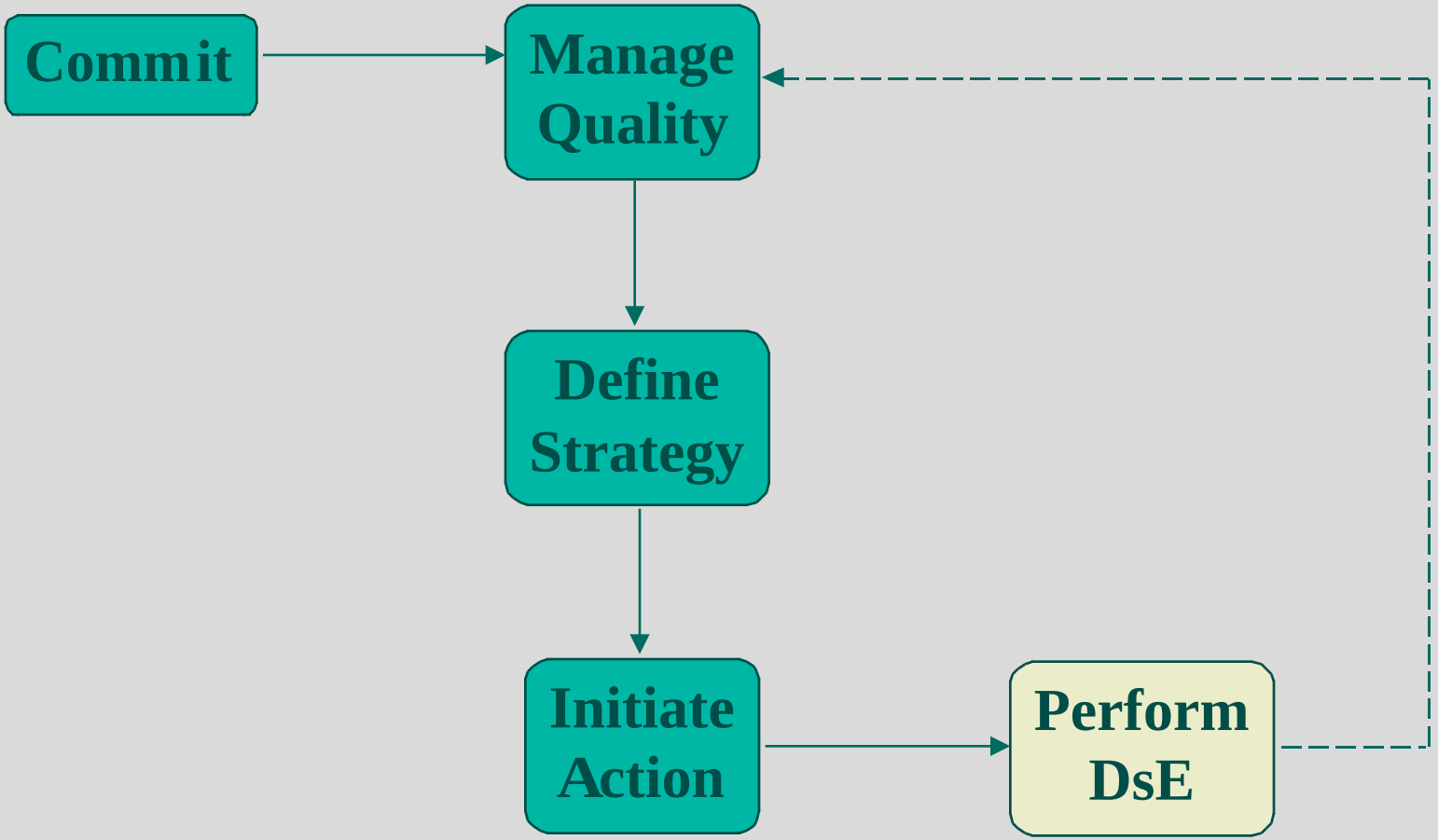
PI_r Process



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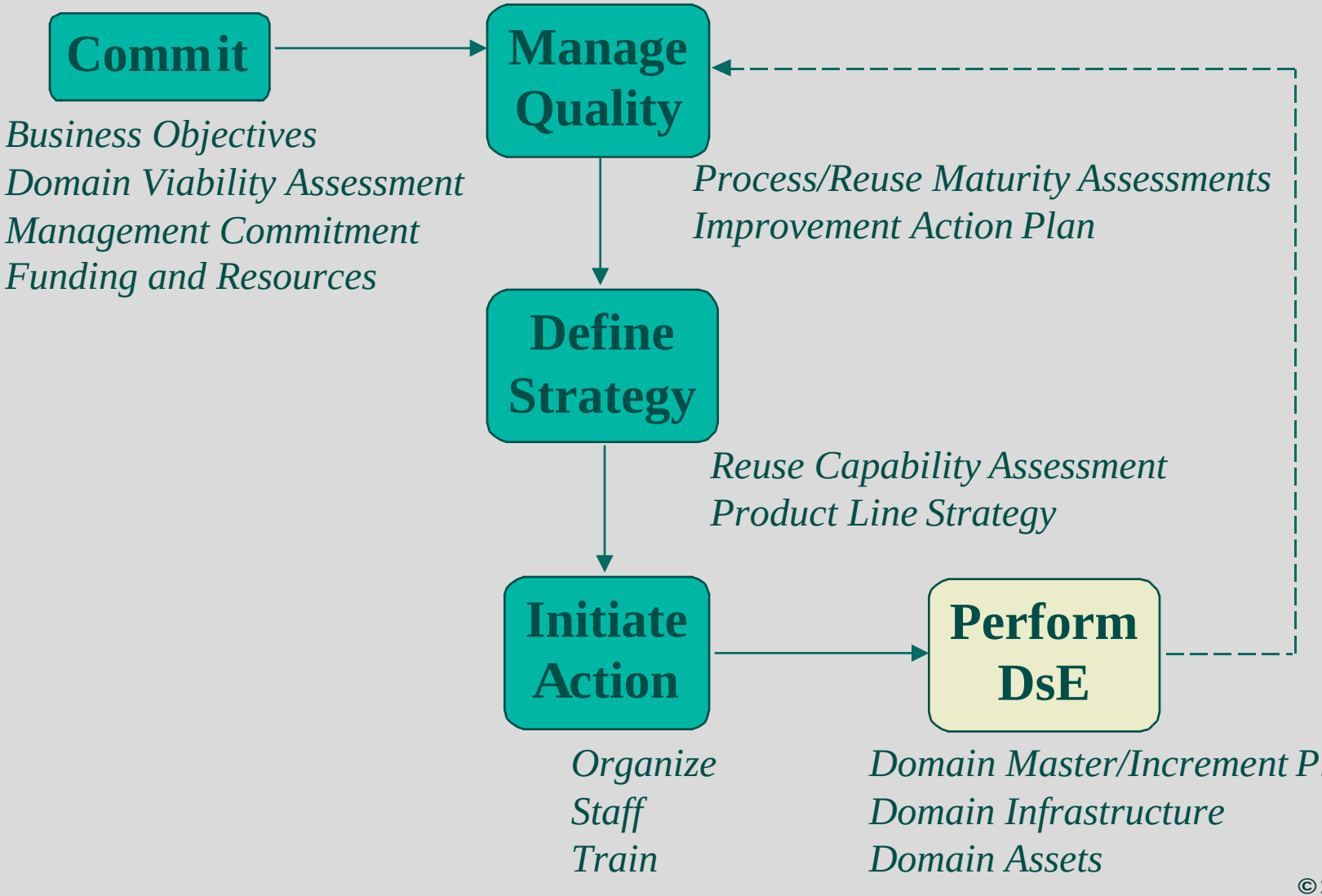
PI_r Process



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Domain Viability Factors

Market opportunity

Technical expertise

Business commitment

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An Intuitive Case for Investment

- A viable future market for a line of similar products (any of the following):
  - Multiple customers who have differing needs
  - A single customer who needs alternative versions
  - Customer needs or supporting technology that are likely to change
- Appropriate management and engineering expertise available (and ideally a legacy of prior products developed)
- Executive commitment to the product line market as a cohesive business area

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What will it cost?

Baseline

- **C_P: your current direct cost to develop a product**
- **N: projected number of future products**

Rough order-of-magnitude cost factors

- **Organization transition cost = C_P * 0.5**
- **C_{DE}: Total DE cost = C_P * 2.0 {?[1.0–>3.0]}**
- **C_{AE}: Product direct cost = C_P * 0.1 {?[0.5–>0.01]}**
- **Product weighted cost = C_{AE} * (1 + C_{DE} / N)**

Projected future cost

- **without DsE = C_P * N**
- **with DsE = C_P * (2.5 + N * 0.1)**

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Process Maturity Factors

Customer/supplier relationships

Engineering methods

Project management

Product quality and integrity

Organizational infrastructure

Process predictability

adapted from SPICE process categories

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Reuse Maturity Factors

Product line strategy and management

Commonalities and variabilities

Availability, quality, and utilization of assets

Process tailoring and product adaptability

Institutionalized knowledge & expertise

Organizational infrastructure practices

adapted from the SPC Reuse Capability Model

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Reuse Capability Factors

Management integration

Needs orientation

Product integration

Stability – optimization

adapted from the SPC Reuse Capability Model

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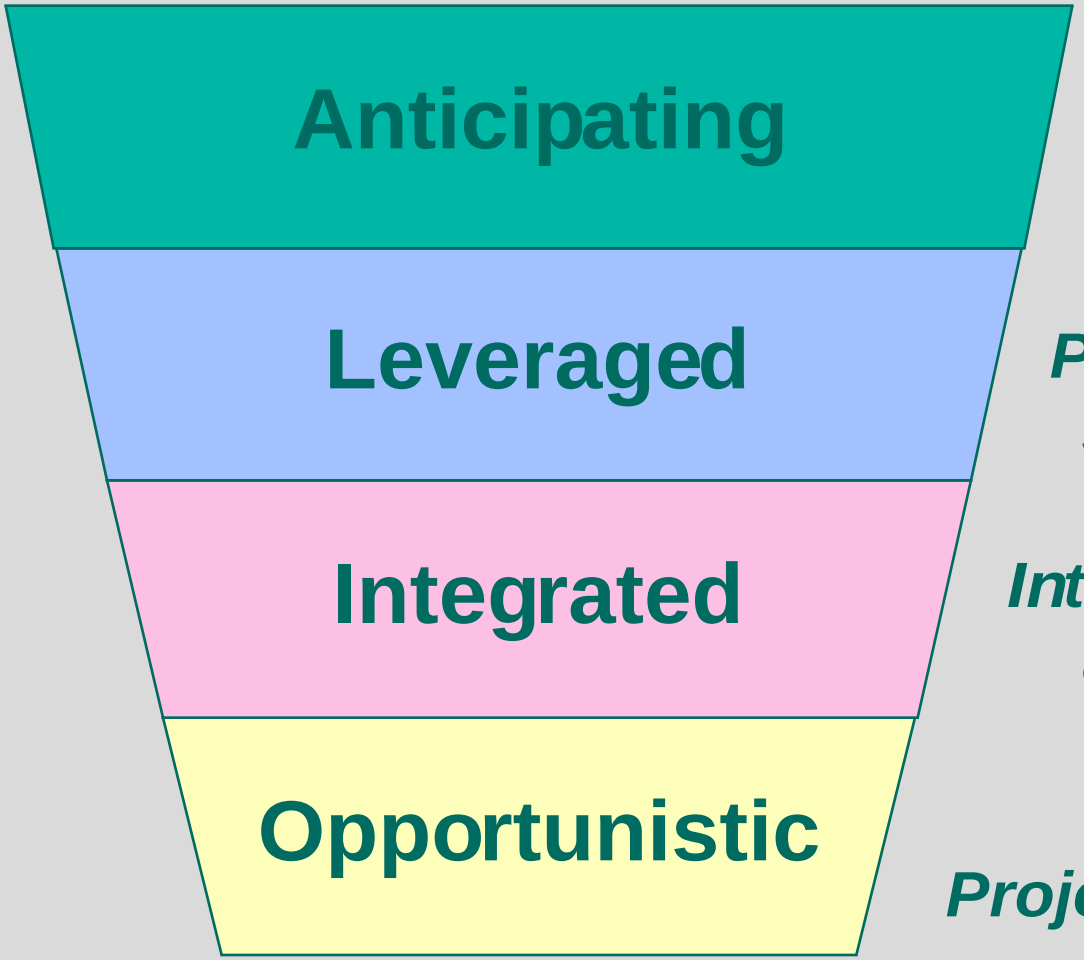
4 Levels of DsE Capability



Domain-Market Coevolution

Products/Process Standardization

Integrated Products & Management

Enhanced Project-level Reuse

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Opportunistic

Enhanced project-level reuse within a conventional process focused on work products

- Application engineering:
  - Autonomous independently planned projects
  - Focused entirely on meeting customer needs
  - Plan so as to accommodate opportunities for reuse during work product development
- Domain engineering:
  - Structure and schedule activities that align with AE project practices and plans
  - Provide reusable work product components that current projects will need

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Integrated

Integrated management, integrated products

- **Application engineering:**
  - **Coordinate planning and priorities to limit redundant and divergent efforts**
  - **Prefer to use domain capabilities over handcrafting when fit is reasonable**
- **Domain engineering:**
  - **Provides a capability to create integrated products, focusing on what is best understood**
  - **Uses projects' feedback as primary guide to needed work**

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Leveraged

Standardization of products and process, based on strategic business objectives

- **Application engineering:**
  - **Use domain capabilities to provide best-fit, whole products rapidly to customers (reuse is largely implicit)**
  - **Hand tailor a product as a last resort to resolve critical shortcomings**
- **Domain engineering:**
  - **May give precedence to business objectives over current project needs in planning**
  - **Standardizes a streamlined AE process oriented to a product family**

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Anticipating

Market and domain in a positive feedback loop for co-evolution

- **Application engineering:**
  - **View domain capabilities as best means to respond to customer needs**
  - **Seek projects that exploit or enhance product line capabilities**
  - **See unprecedented needs as opportunities for domain evolution**
- **Domain engineering:**
  - **Anticipates market needs and trends**
  - **Provides capabilities with a cost/benefit profile to drive market evolution**

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Product Line Strategy

Market/products focus

Business model

Tailored process model

Organizational structure

Support environment

Transition strategy

adapted from the SPC Reuse Adoption method

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Market/Products Focus

- **Preliminary: Business objectives**
- **Refined: Domain viability assessment**
- **Revised: Domain engineering (Domain objectives, Domain Definition)**

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DsE Business Models

- R&D funded
- Projects funded from product revenues
- Customer funded and owned

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Process Model Tailoring

Preferred software development methods

Targeted initial level of DsE capability

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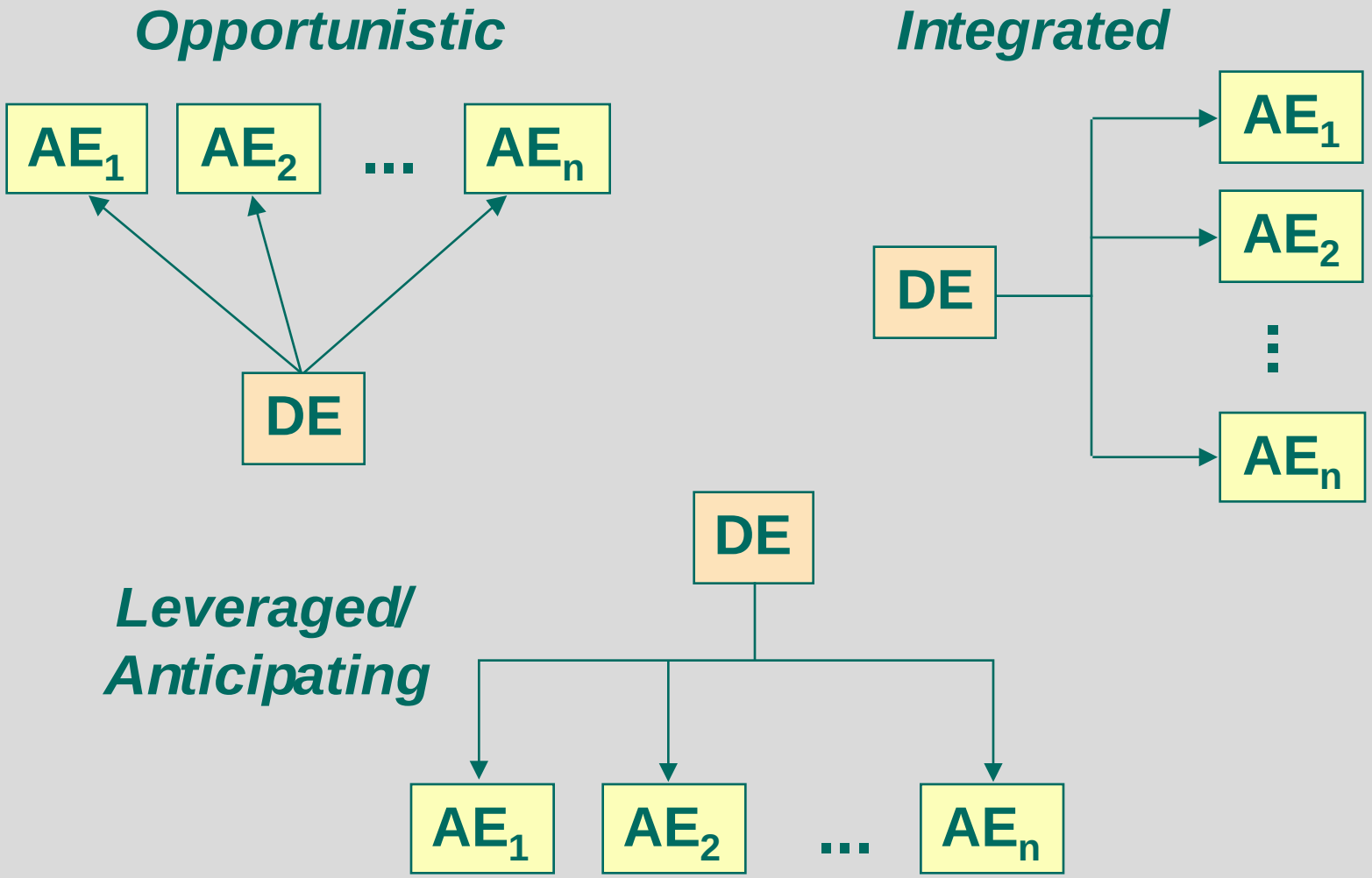
DsE Product Line Organizations



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Support Environment

- Configuration management tool
- Method-compatible software development tools
- Process modeling tool
- Project management tools
- AE environment development tools
  - User interface
  - Database
  - Metaprogramming

This is the support environment for DE, not the AE environment which is the responsibility of DE.

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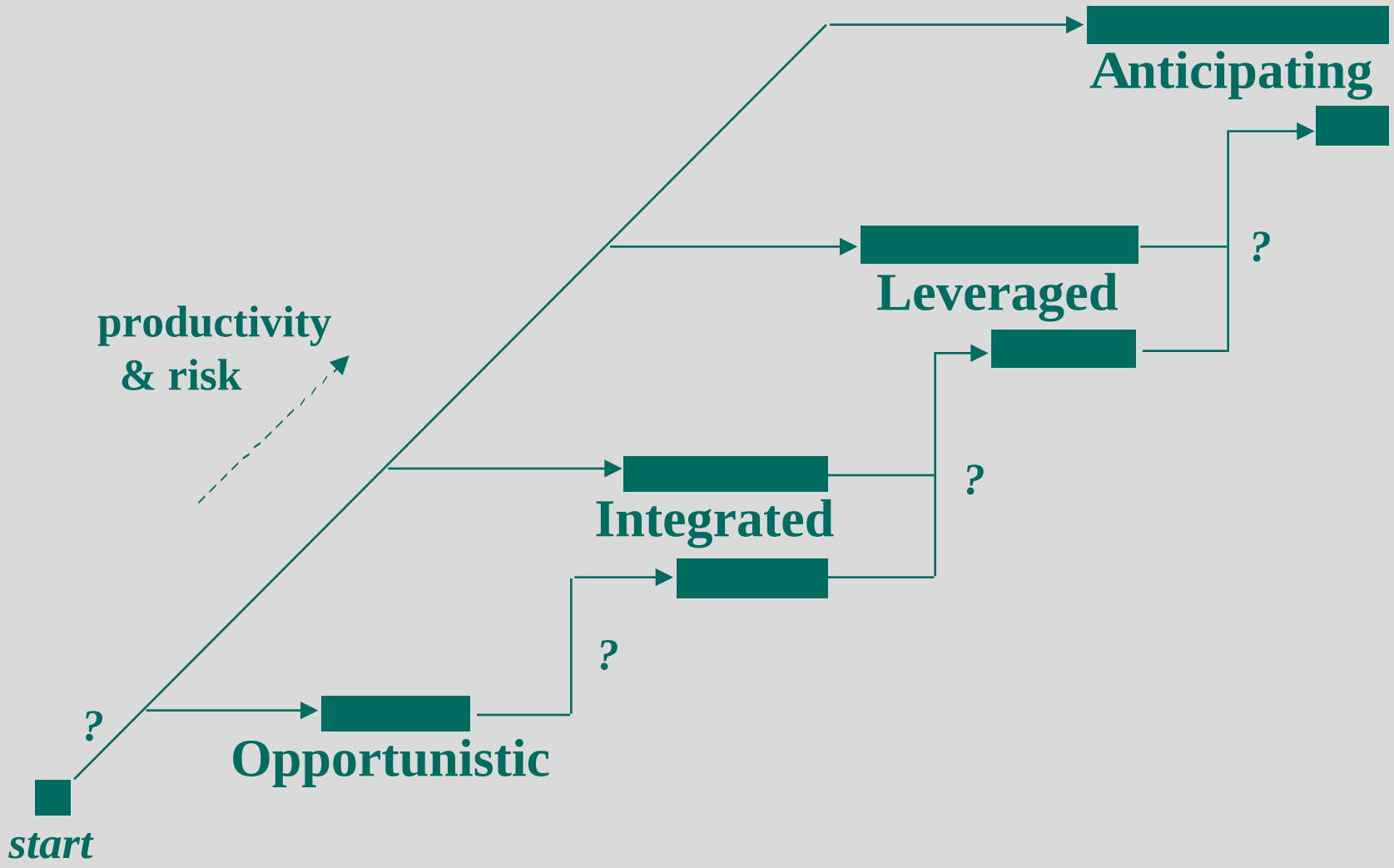
Alternative Transition Strategies



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Potential Organizational Impacts

- Assignment of key managers and engineers to creating a domain capability, away from directly serving customers' current needs
- Substantial training and reorientation of managers, marketers, and engineers
- Long-term financial investment in software as a capital asset
- Coordinated planning and management of projects within the product line business
- Concerted efforts to improve practices in all aspects of the business, from strategic planning and marketing to methods and tools

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Instituting DsE

Organizational actions

- **Evaluate utility**
- **Initiate pilot efforts**
- **Provide training and support**

Domain-specific actions (3-4 month pilot efforts)

- **Define a preliminary product line focus**
- **Evaluate domain viability**
- **Analyze commonalities and variabilities**
- **Develop selected adaptable components**
- **Initiate the PI_r process**

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A Beginning Action Plan

- Draft a preliminary adoption strategy for a selected product line business area, based on a preliminary domain viability assessment (1 week).
- Develop a domain engineering capability, creating a domain framework for the product line (3 increments over 4-6 months).
- Initiate the adoption process to refine the product line approach (2 weeks).
- Implement a first usable increment of the domain, targeting 2-3 application projects (3 increments over 6-9 months)

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