1.463 Globalization
Technological Innovation and Assessment for Construction Industry

Session 10

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Economic Development

- Post WW II
- Factors of Production:
  - Labor Intensive
  - Capital Intensive
  - Knowledge Intensive

  - *Productivity = f (labor, capital, knowledge)*

Four Major Technologies which Contributed to the U.S. Success in World War II

- Weapon
- Transport
- Communication
- Construction

Innovation

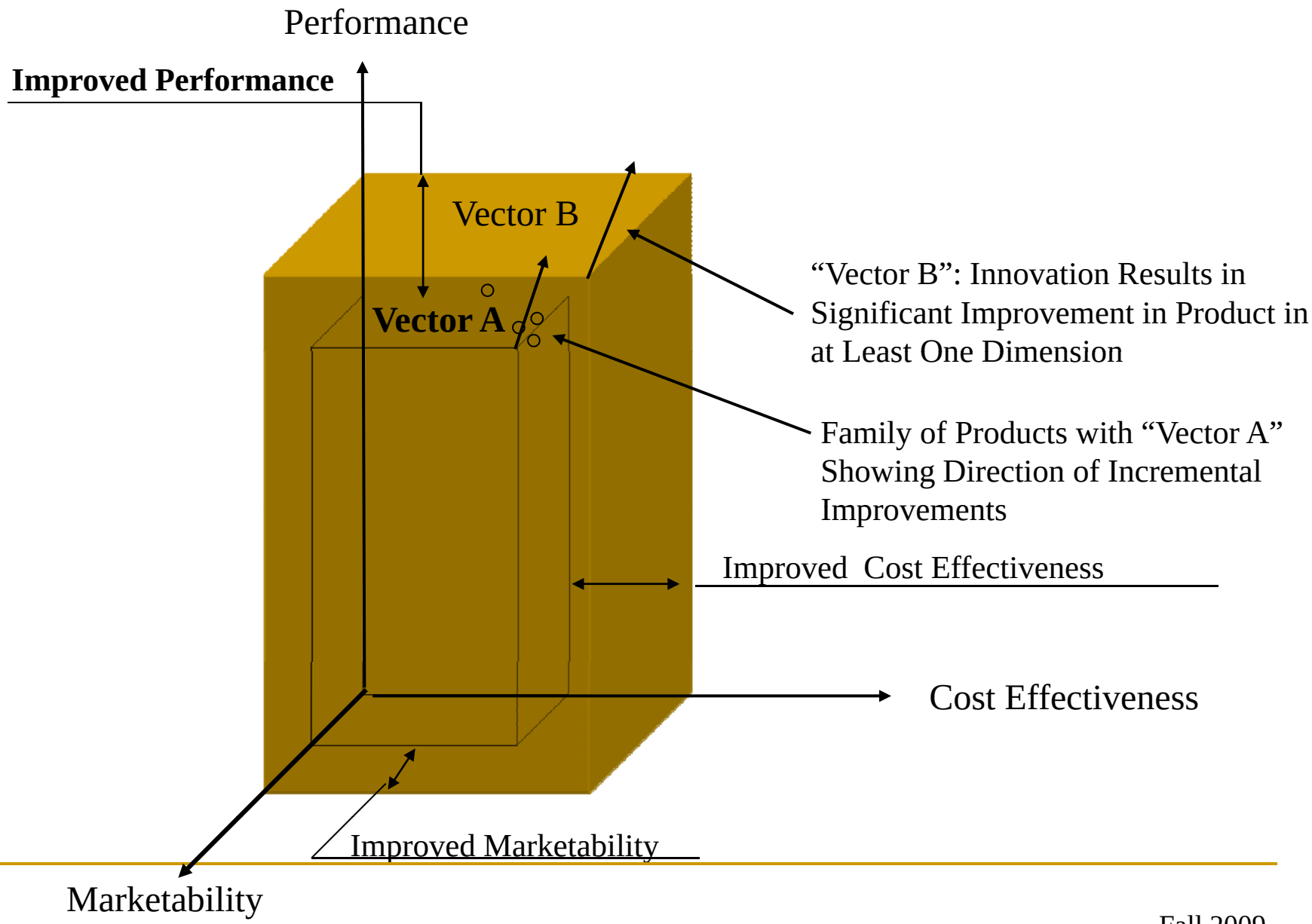
- Major technological and management innovations require major commitments to research
- Current commitments are primarily for incremental improvements
- What is needed is a dramatic change involving: radical realignment of how things are done.

"Being innovative"

Process of Innovation

- Process of Innovation is Risky and Uncertain
- Would not be Undertaken if Entrepreneurs Were Rational
- It Requires Technical Finesse and Market Savvy
- Thus Heavy Mortality Rate for Innovating and Non-Innovating Firms

Three Dimensions of Product and Process Innovation



Innovation

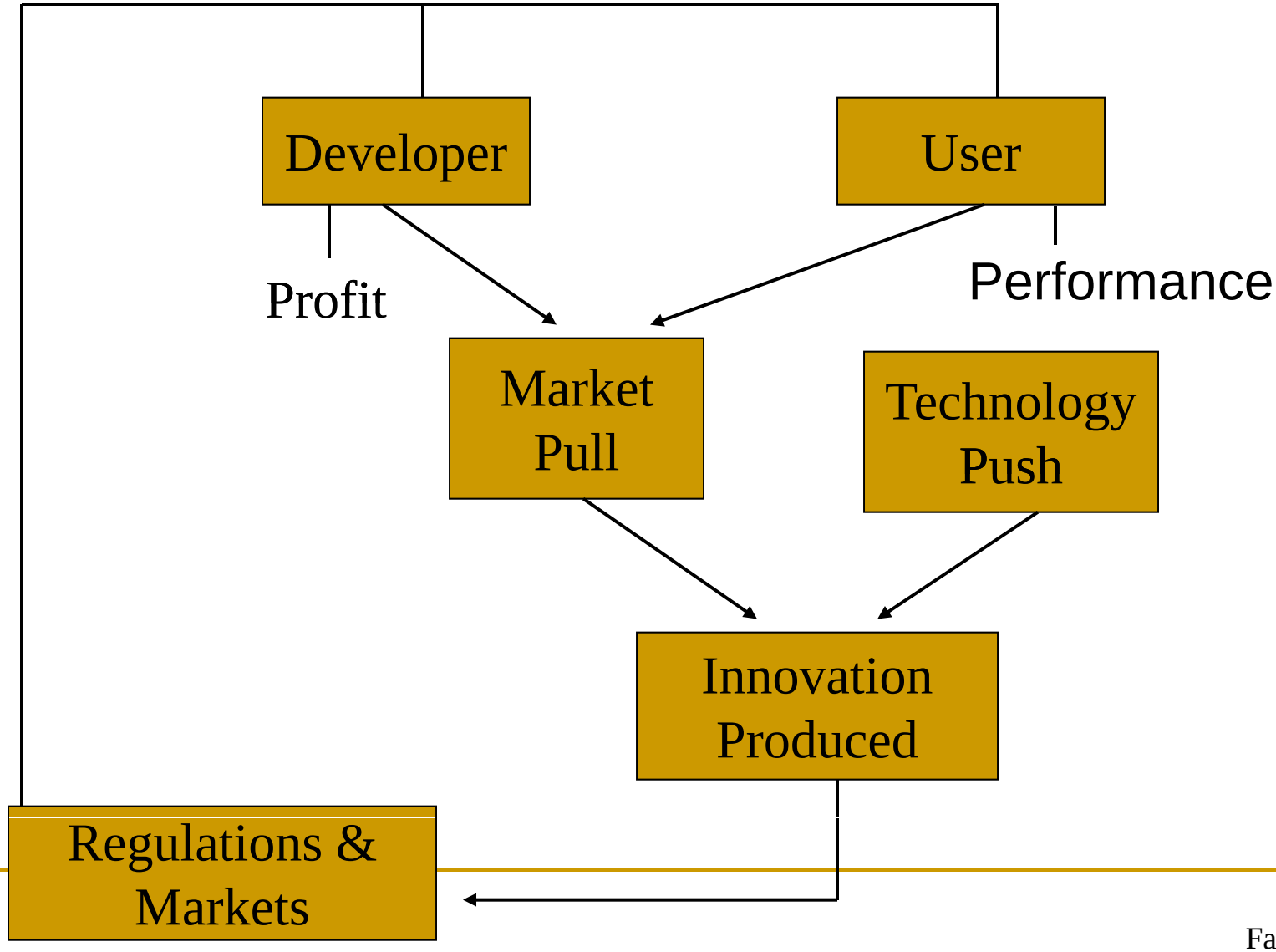
Market Pull

e.g., Energy Efficient Systems

Technology Push

e.g., Information Technology and Communication Technology

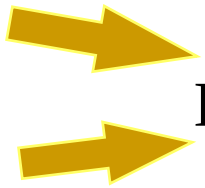
MARKET PULL AND TECHNOLOGY PUSH



Technology Push

Needs Technology Family Understanding
in Terms of:

- Technology
- Performance
- Cost Effectiveness



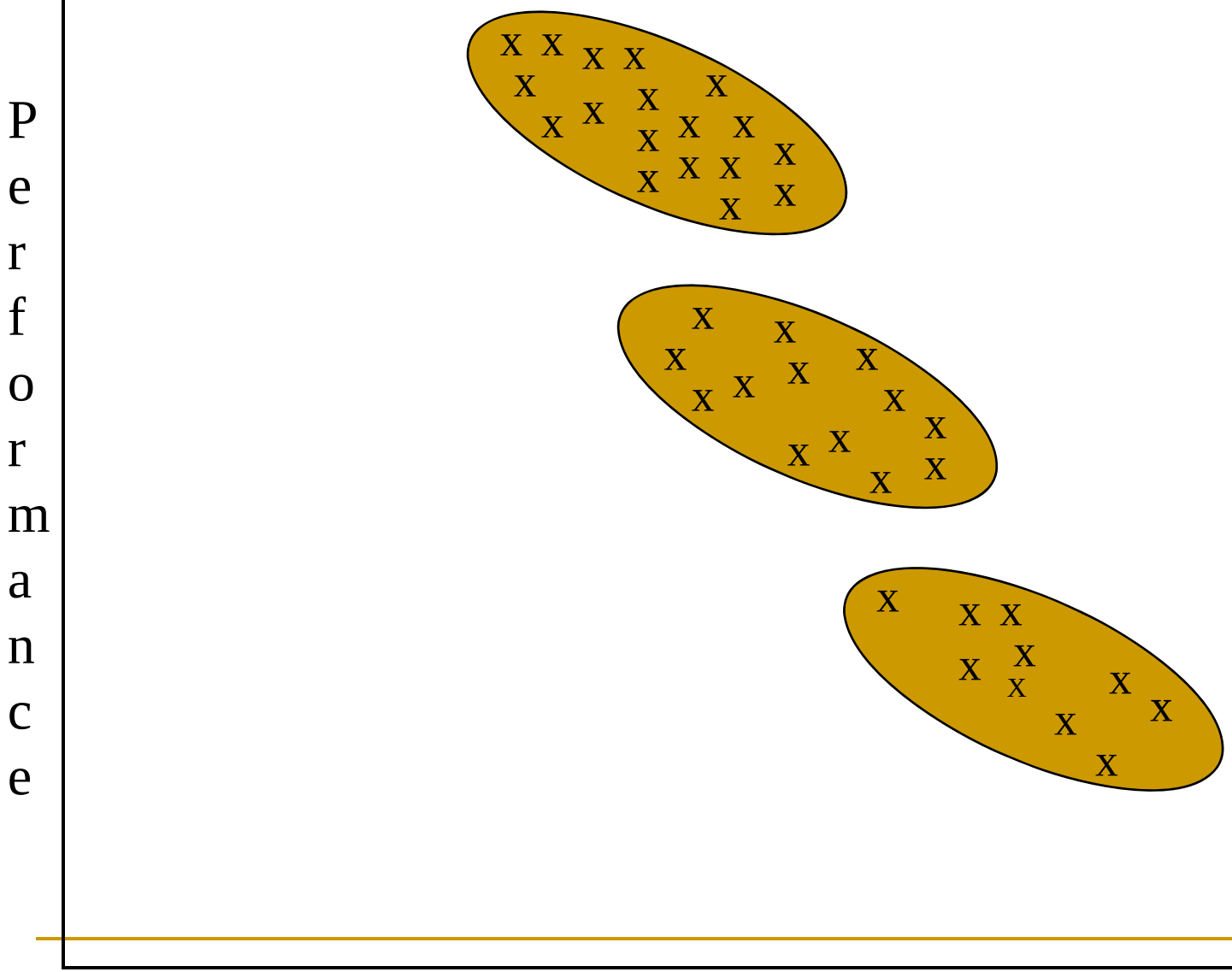
Engineering Effectiveness

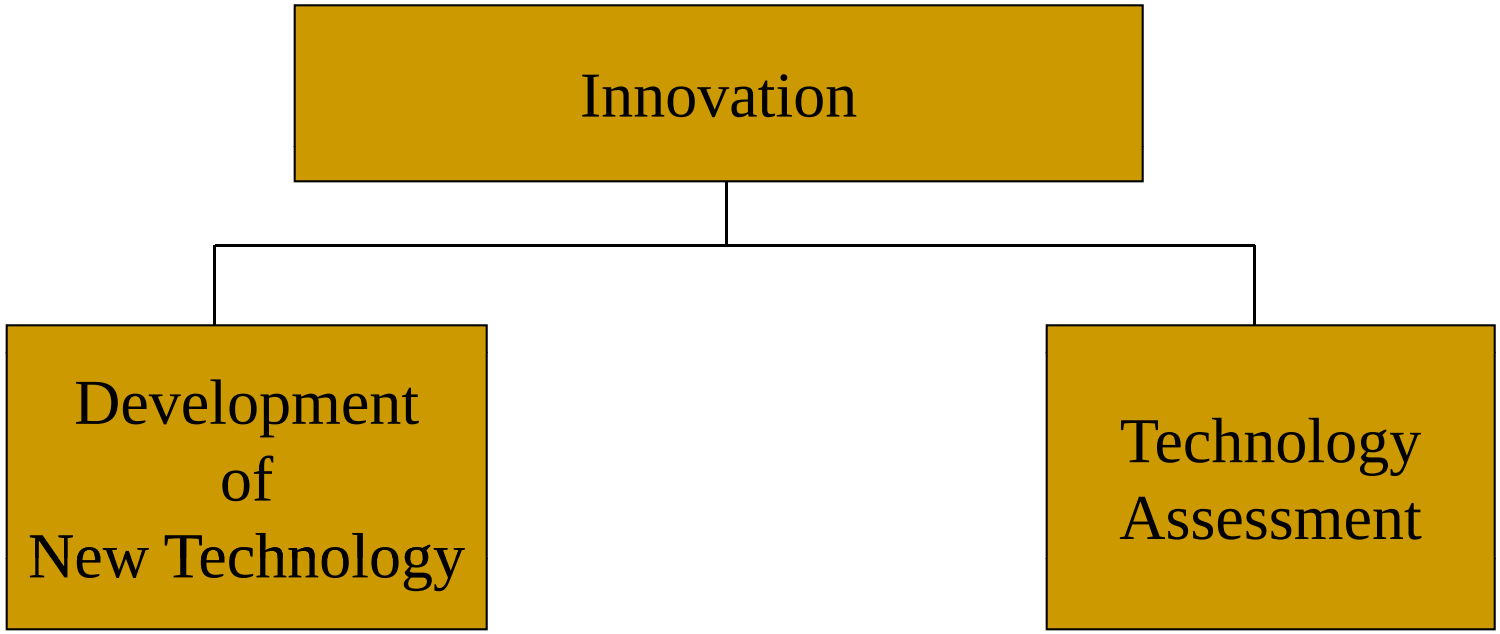
Engineering Effectiveness

PERFORMANCE: A set of quantifiable disaggregated attributes that describe the services provided by a product/process.

TECHNOLOGY: A set of quantifiable disaggregated physical attributes that are responsible for the performance in question.

Family of Innovations

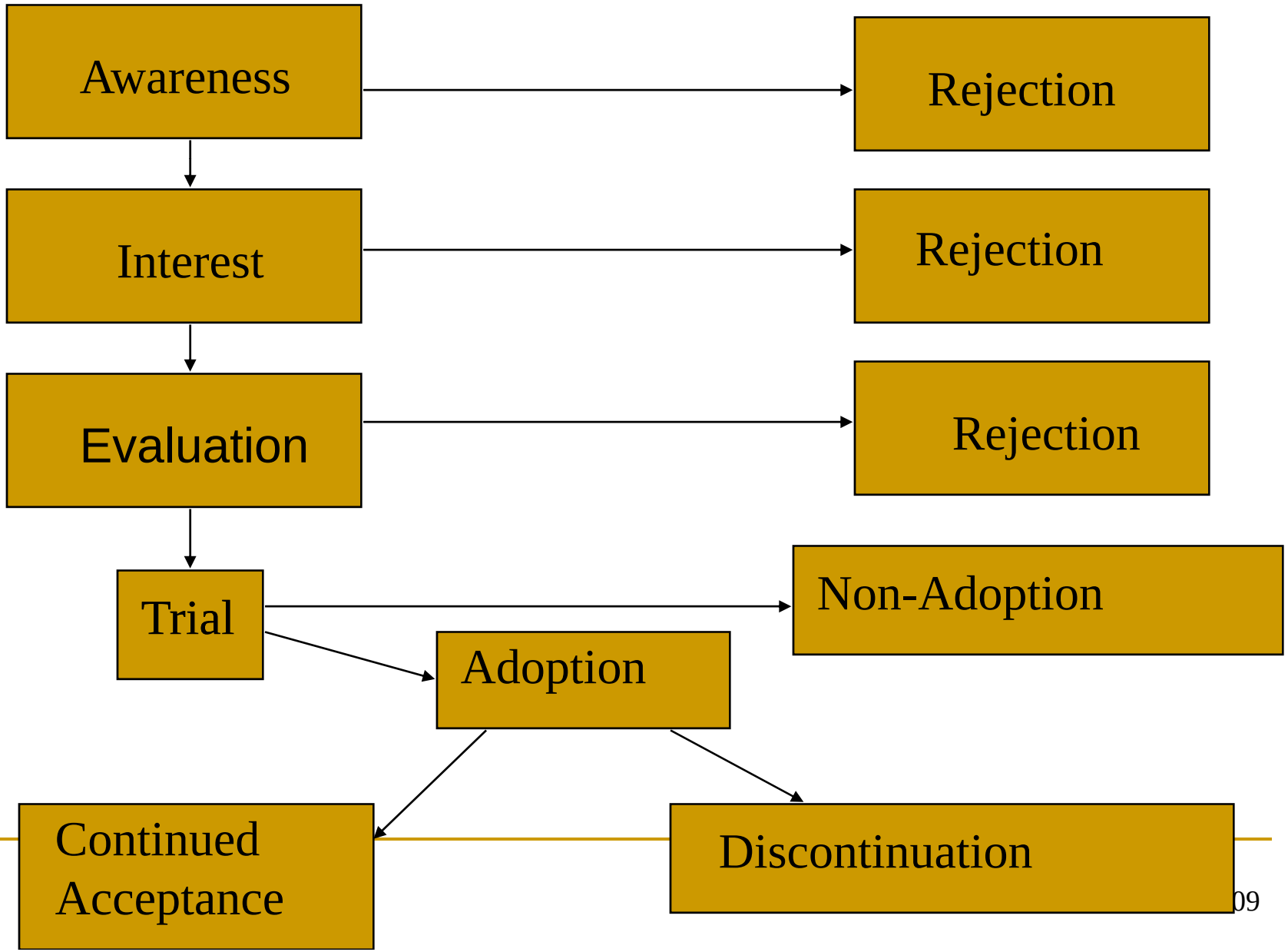




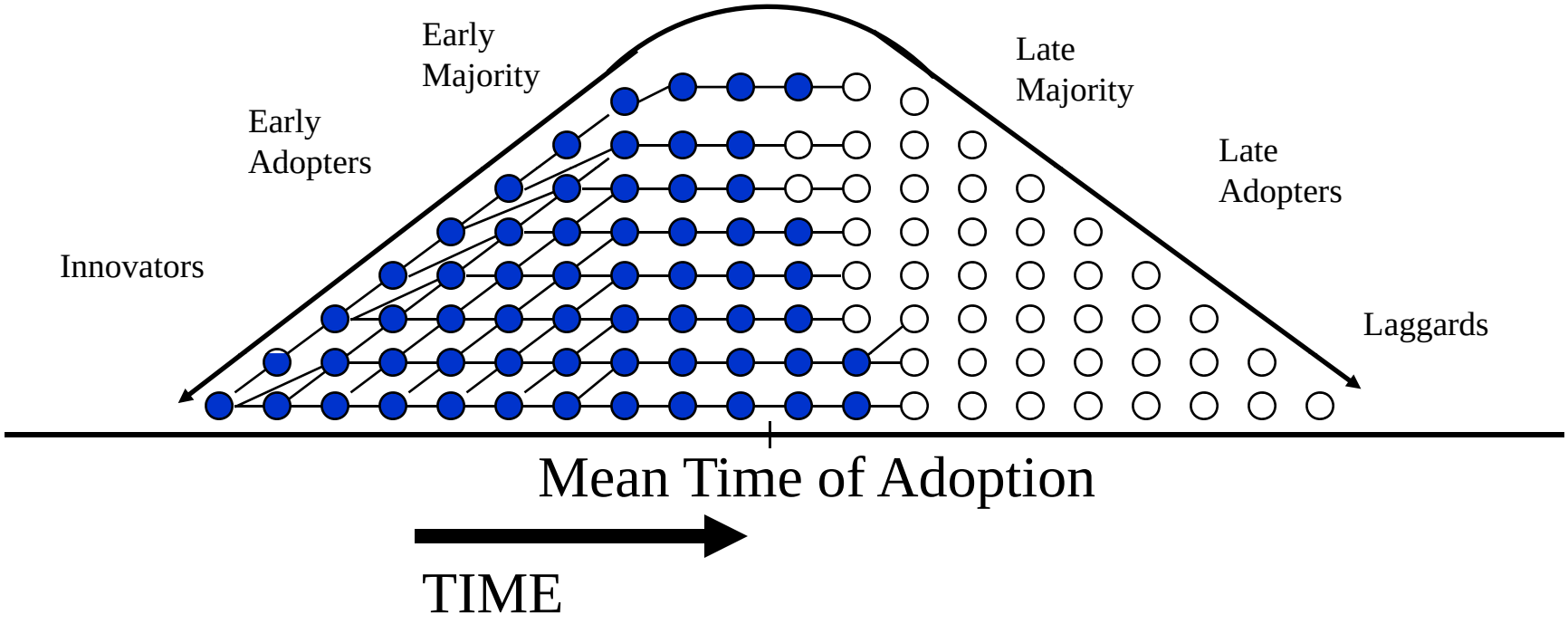
- Basic Sciences
- Manufacturing Technology:
  - Automation & Robotics
  - Advanced Materials
  - Computers & Information Technology

- Risk Assessment
- Innovation/Diffusion
- Productivity
- Competitiveness
- Cost

Adoption Process



The Dissemination of Innovation



Innovation

1. Achievement of Actual Improvements in Productivity

2. Significant Advancement in Capabilities

3. Facilitation of Implementation of Innovative Technology in the Industry

Impact on Value Added Captured at Industry Level

- Impact on Productivity
- Impact on Cost
- New Markets

Economics of Innovation

Basic Motivations

- Higher profit margins and higher rates of return through premium products
- Larger slices of the pie through adding value in earlier stages of value chain
- Early entry and thus controlling the technological direction
- Increased Marketability (Trade Names, Etc.)

Technology Assessment

In order to evaluate the existing and emerging technologies we need to develop a framework that would:

a) assess the emerging technologies through strategic options available on the demand as well as the supply side;

b) analyze the cost and benefit of these strategies for long-term performance of the systems;

c) develop an understanding of risk associated with each undertaking and the manner by which the risk can be managed.

On the Demand Side focus is on

a) market aggregation and economic incentives;

b) develop strategic alliances with other users of the system;

c) comparing marginal cost of production with marginal cost of conservation;

d) privatization

On the Supply Side focus is on:

a) developing mechanisms whereby the developers of new technologies could be encouraged to expedite the development of the more advanced systems;

b) explore the desirability of developing technological alliances with others:
i) by taking minority position,
ii) providing venture capital,
iii) providing R&D facilities for development of the emerging technologies.

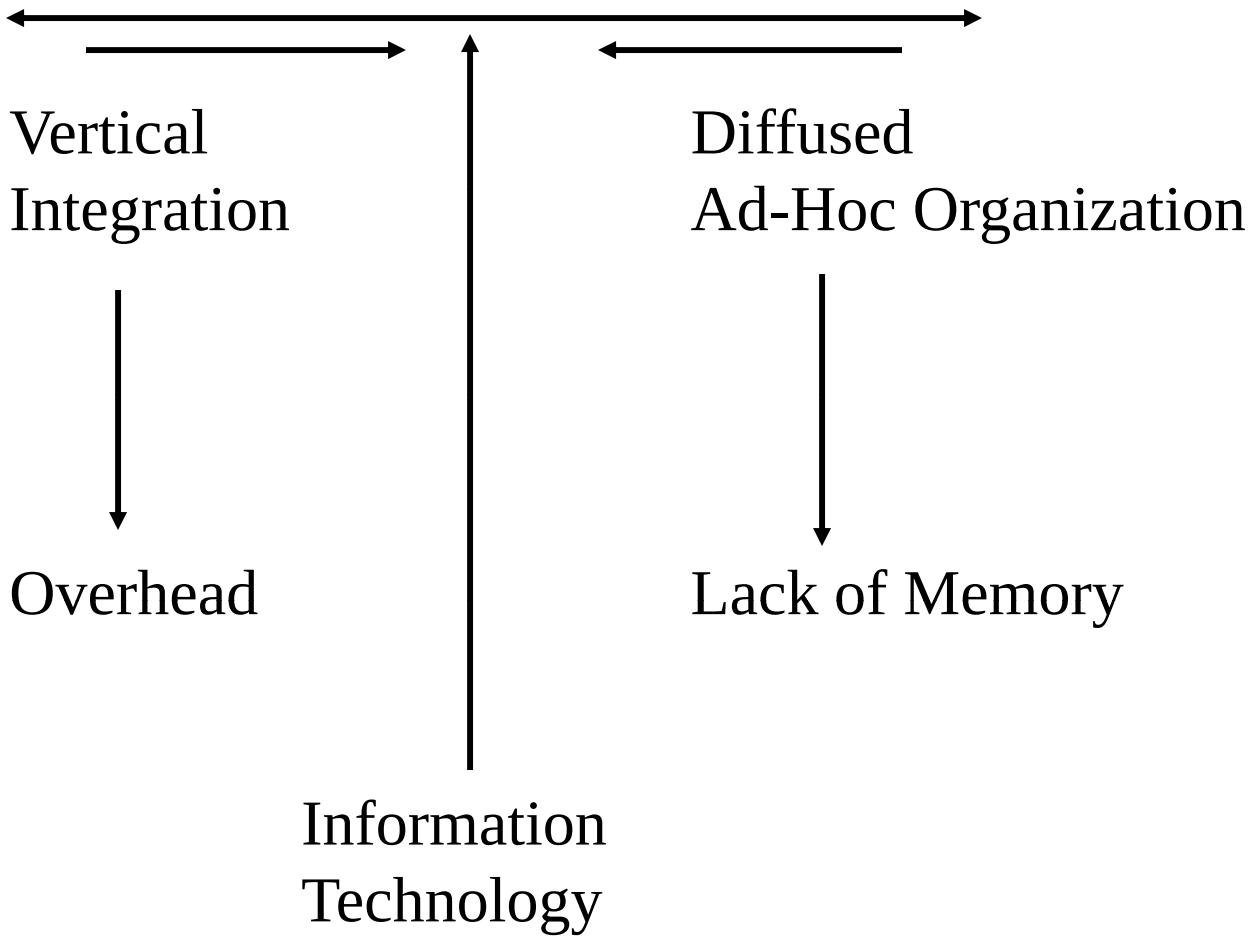
Risk Evaluation and Risk Management will focus primarily on;

a) risk associated with disruption of the system due to technological failures;

b) transferring risk from one strategic resource to another;

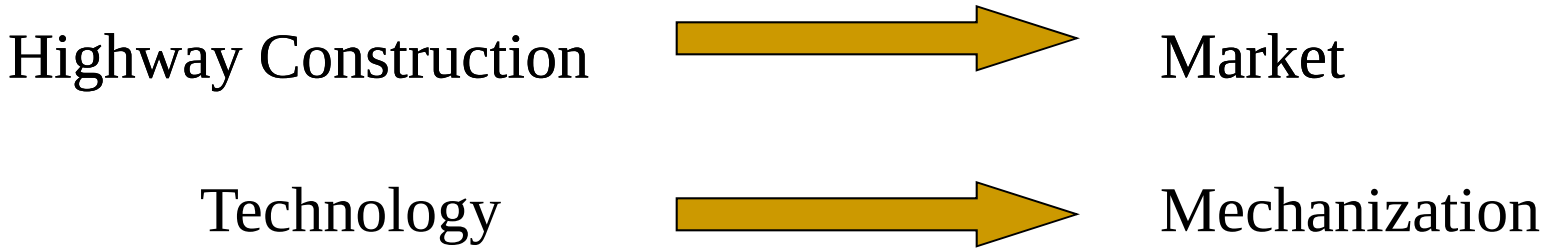
c) risk involved in market reaction: es pecially reaction of global market to perceived notion of scarcity or supply instability;

d) risk associated with the investment in new technologies.


Vertical
Integration
Diffused
Ad-Hoc Organization
Overhead
Lack of Memory
Information
Technology

Historically a Similar Situation Existed in the 1920's

When the industry's productivity increased by almost an order of magnitude due to the confluence of technology and market.



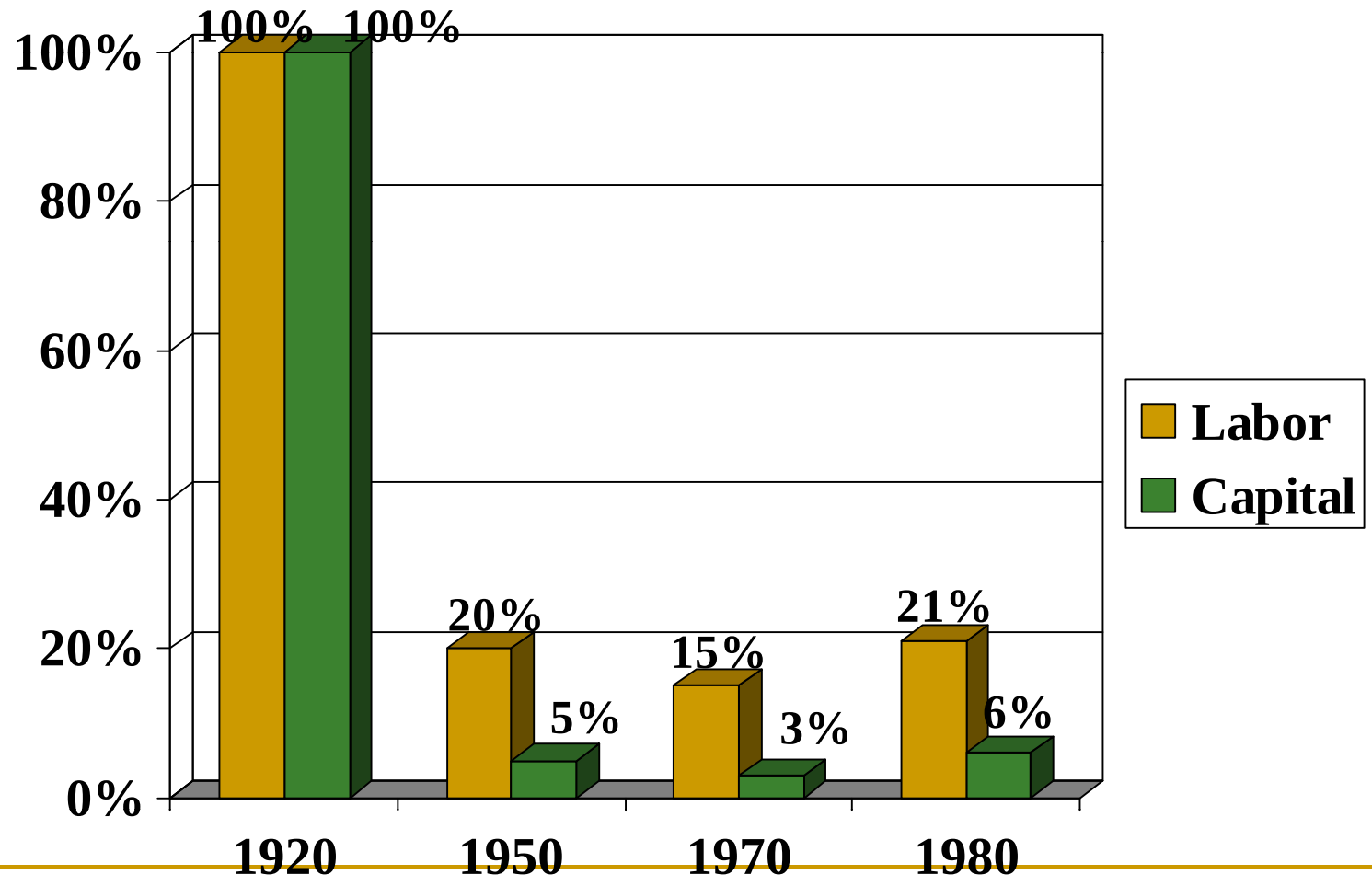
Similar Opportunities Exist Today

Market Stability  Infrastructure

Technology

- Information & Communication
- Robotics
- Engineered Materials

Surfacing


100%
80%
60%
40%
20%
0%
100%
100%
20%
5%
15%
3%
21%
6%
1920
1950
1970
1980
Labor
Capital

A Tentative Methodology for Technological Assessment

Fall 2009

General Premises

1. An objective to improve the productivity of construction and reconstruction in a fundamental and far-reaching way;
2. An assumption of a changing market in which infrastructure renewal will present a unique opportunity to exploit the benefits of technological change; and
3. A recognition of three primary fields in which emerging technologies present great promise for increased productivity in the construction industry;
    - Automation and Robotics including remote sensing, remote controlled, intelligent tools and equipment
    - Information technology including broad advances and applications of both hardware (e.g., equipment, guidance and control, data acquisition) and software e.g., artificial intelligence and4D systems;
    - Materials and Processes including high strength, and high stiffness metals, ceramics and composites, anti-corrosion techniques, and high-performance engineered materials. Eventually nano and bio materials.

Technological Strategy

Premise

- Uncertainties about appropriate technologies and market preferences in the future raise fundamental strategic questions about the core competencies which a firm or organization must have to be competitive in the long term.

- As more markets become technologically dynamic and as market preferences become more volatile, a growing challenge in strategy is to develop a coherent framework for formulating competitive strategy in the face of significant technological and market uncertainty.

- "Our premise is that the objective of a strategy is to devise a plan of action which, if carried out successfully, will maximize the value."

Objective:

- A basic objective is to build an argument for emphasizing the fundamental importance of alternative technologies and strategies in overall competitive strategy of a firm.

- A perspective which has strongly influenced the framing of this objective is the view that the ultimate source of value is the development and provision of technologies which are valued by the marketplace.

- Given this perspective, concerns about which strategic resources and which organizational processes a firm should acquire depend on how given resources or processes would affect the ability of the firm to compete in specific markets.

Strategic Flexibility

- Strategic flexibility is essentially the ability of the organization to choose alternative actions at some time in the future.

- Options pricing models is being increasingly used as the basis for the study and valuation of strategic flexibility and, by extension, for the determination of optimal (i, e., value-maximizing) strategies based on strategic flexibility.

In the strategic flexibility framework

- The strategic actions that can give rise to initiative options are essentially the efforts to develop appropriate technologies.

- Timing options are then associated with specific technology initiative options, and those operating options encompass all the possible forms of

- operating flexibility one has in deciding when to begin, terminate, shut down development of a technology.

- The implementation options associated with an initiative option define the choice one can make about how it develops and produces technologies, including choices of scale, partnerships, product position, geographic markets, modes of distribution, requirements for human skills, etc.

Using options theory as the economic framework for the Study of strategic flexibility leads to the following propositions:

- Strategic flexibility in its essential features is exhaustively defined by a limited number of basic kinds of choices.
- These basic kinds of choices are described by a number of *"generic real options".*
- Given certain representations of uncertain future outcomes, these "*generic real options*" can be valued.
- Therefore, the search for the optimal strategy for facing uncertainty becomes an effort to identify the value-maximizing set of real options that can be acquired, and this value-maximizing set of real options constitutes the optimal strategic flexibility which the organization should strive to acquire.

Examples of Options

- The option to abandon a project
- The option to shut down a project temporarily
- The option to wait to invest in a project
- Valuing flexible production systems
- Determining optimal natural resources allocations

Fundamental Choices

Strategic flexibility can be reduced to certain fundamental choices an organization can make as to:

i) what strategic actions it will initiate *(initiative options)*,

ii) when it will undertake its strategic actions *(timing options)*,

iii) how it will implement its strategic actions *(implementation options)*.

Generic Real Options #1: Initiative Options

(1a) Option to choose whether or not to develop a new technology

(1b) Option to choose a single (most valuable) technology to pursue from among two or more alternative technologies.

(1c) Option to choose two or more (most valuable) technologies to pursue from among multiple alternative technologies.

Generic Real Options #2: Timing Options

(2a) Option to wait to develop a technology.

(2b) Option to shut down development temporarily

(2c) Option to abandon development of a technology

Generic Real Options #3: Implementation Options

(3a) Option to manage the demand for the output of the organization.

(3b) Option to expand the supply of the output of the organization.

(3c) Option to improve the efficiency of the processes of the organization.

(3d) Option to change the output rate of the organization.

(3e) Option to reduce the response time to changes in technology or market preferences.

*"**Unobtanium** is a material that weighs nothing, is enormously strong, withstands high temperatures, lasts forever, is easy to make, and costs almost nothing."*

1.463J The Impact of Globalization on the Built Environment
Fall 2009