Gap Analysis: Rethinking the Conceptual Foundations

Gary Langford, Presenter

Lecturer, Naval Postgraduate School

Gap Analysis: Rethinking the Conceptual Foundations

- **Gary O. Langford, Lecturer,
  Department of Systems Engineering,
  Graduate School of Engineering & Applied Sciences**

- **Raymond (Chip) Franck, Senior Lecturer,
  Graduate School of Business & Public Policy**

- **Tom Huynh, Associate Professor,
  Department of Systems Engineering,
  Graduate School of Engineering & Applied Sciences**

- **Ira Lewis, Associate Professor,
  Graduate School of Business & Public Policy**

Gap Analysis: Methodology & Analysis That Facilitates Planning & Acquisition

- "What you desire versus what you have" is viewed as a Gap.

- The Gap is manifest in the difference between
  - What is perceived important against what you have, *or*
  - What exists contrasted to what is expected.

Multiple Purposes for Gap Analysis

- Technology Roadmaps
- System Architecture
- Functional Capabilities; Performances, Quality
- Operational Effectiveness
- Operational Suitability
- Estimated Cost for Selected
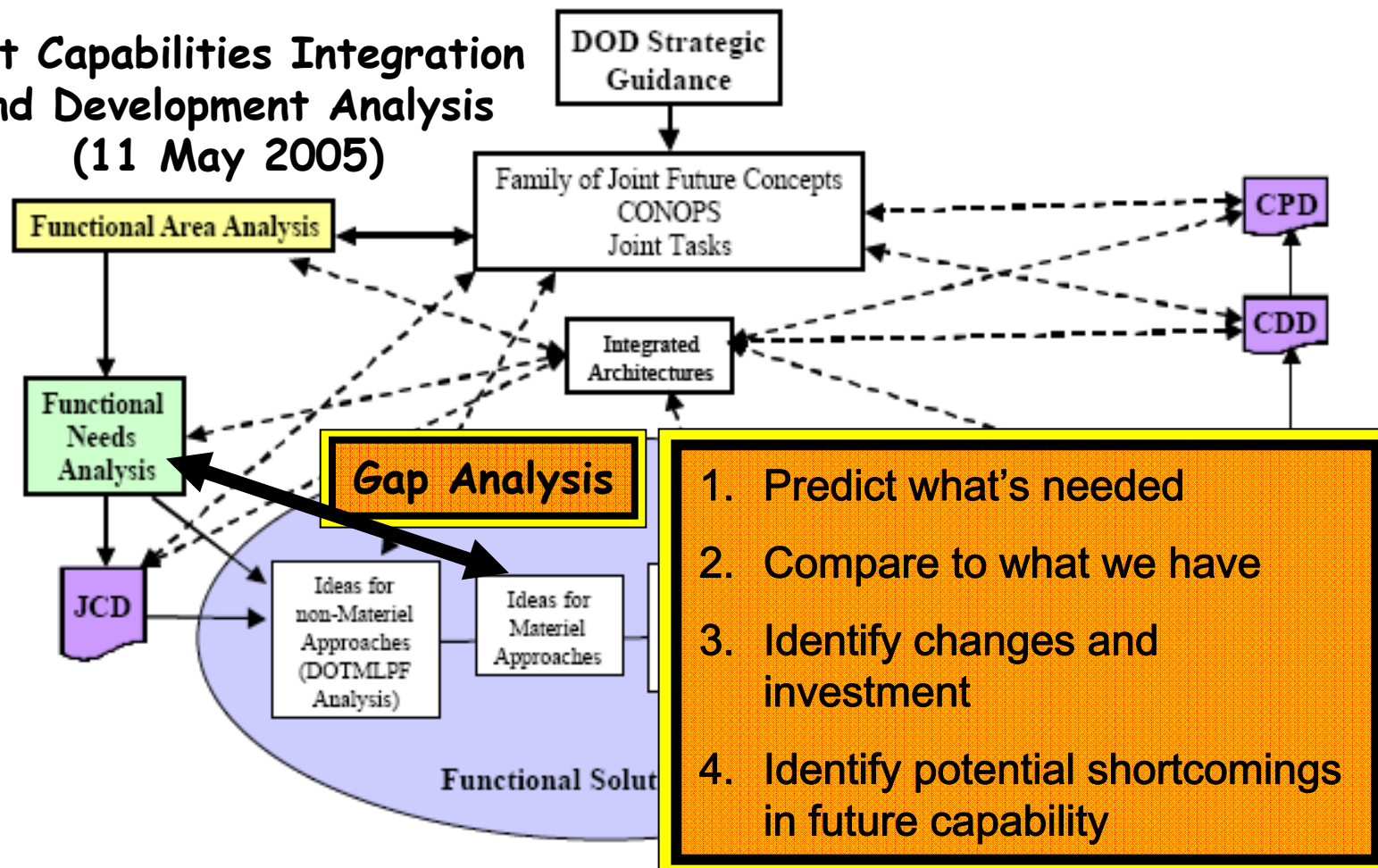- Estimated Costs for Alternatives

Gap Analysis – The Purpose

- *Gap Analysis* loosely defines a method for identifying the degree to which current system satisfies a set of requirements.

- Goal: align anticipated outcome with a future reality that can be achieved.
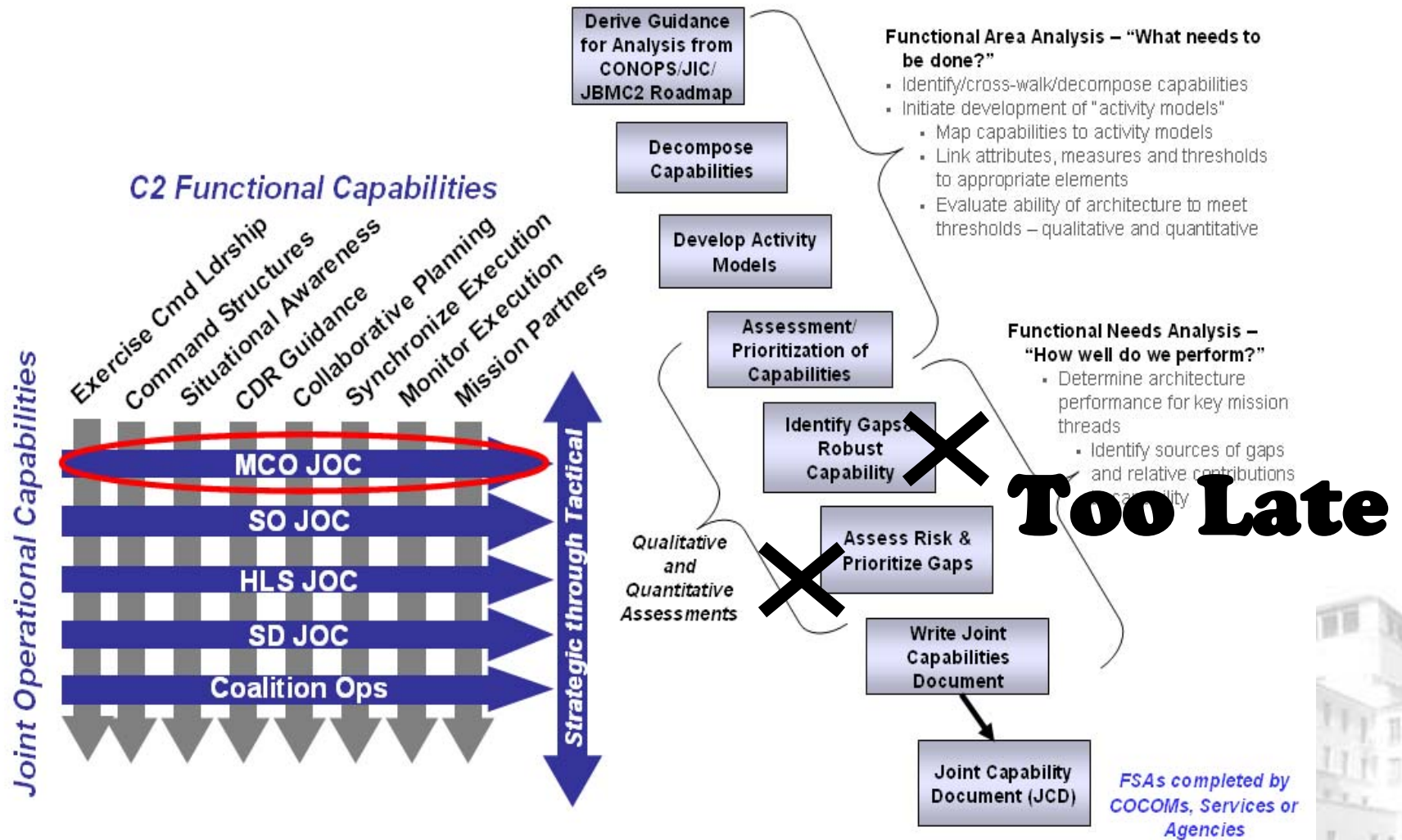
Gap Analysis: The Intended Results

Joint Capabilities Integration and Development Analysis (11 May 2005)

DOD Strategic Guidance

Functional Area Analysis

Family of Joint Future Concepts CONOPS Joint Tasks

CPD

CDD

Functional Needs Analysis

Integrated Architectures

Gap Analysis

JCD

Ideas for non-Materiel Approaches (DOTMLPF Analysis)

Ideas for Materiel Approaches

Functional Solut...

1. Predict what's needed
2. Compare to what we have
3. Identify changes and investment
4. Identify potential shortcomings in future capability

The Scope: Identify Gaps/Assess Risk

Understand Gap Analysis At Its Core

- Determine what constitutes the foundation data
- Relevancy and understanding of data
- Structure information within proper context
- Assumptions from which to extrapolate from current industrial output, technology advances, and engineering developments

- We need a set of consistent methodologies and analysis tools for performing Gap Analysis to aid 250,000 acquisition officials.

Observation: Gaps Follow Mechanical Causal History

- A gap is the difference between two events. There are four causal properties of an event.
  - Future product versus the current product
  - Relationship between current and future events
  - Procedurals that constrain interactions
  - Specific goals and their root actions
- New Concept: Gap Analysis is concerned with difference between the reality and the expected, but not the discrete time-steps between the present and the future.

Need: Revise Formulation of Gap Analysis

- DoD formulates its development interests with a timeline of activities.
- Systems Engineering Process Models are construed and managed as a discrete set of events – time recorded adjunctively.
- Gap Analysis does not reflect when something will happen, only that it will actually happen.
- Redact Gap Analysis into events rather than a process based on timelines, eliminates the reliance on 'wants', yet retains the notional attributes of 'needs'.
- **Consider Event Based Gap Analysis and Worth.**

Worth Compares Use to Investment

- **Worth** is the use that is expected for the investment, the operational capability of a product's functions, performance, and quality.

  – **Functions** are the actions performed (capability)

  – **Performance** qualifies these actions (differentiates)

  – **Quality** is the lifecycle cost of the functions and their performances (determined by losses)

    Worth $= f$ (functions, performance, quality)

  Gap Analysis should answers two questions: which course of action has higher worth and how much more.

Postulates and Determinations

General Notion: Value = Performance / Cost

$$V(t) = \frac{\sum F(t)P(t)}{I(t)}$$

where *F(t)* is a function performed by the system, *P(t)* is the performance measure of the function, *I(t)* is the investment (e.g., dollars or other equivalent convenience of at-risk assets) and the time, *t*, is measured relative to the onset of initial investment in the project.

Worth: Defined by Both The Road and The Destination

General Notion: Value = Performance/Cost

$$W(t) = V(t)Q(t) = \frac{\sum F(t)P(t)Q(t)}{I(t)}$$

- Worth = Value * Quality
- Quality represents a loss function
- Value interpreted with loss can represent risk
- Complexity can be interpreted through risk
- Stakeholder analysis defines Worth

Development of the Gap Analysis Equation

$$W(t) = V(t)Q(t) = \frac{\sum F(t)P(t)Q(t)}{I(t)}$$

Expand Investment, I, to a $/hr * # hrs

Multiply top & bottom of equation by P

Therefore:

Worth [per function(s)] = P/c/t * P/T * Q/P

    where P = work done; c / t = cost / hr; T = total time; and Q = Minimum loss - loss function, L(x)

L(x) = k(x-m)^2 (standard loss function)

    where k = $ (unit)/variance, k = constant
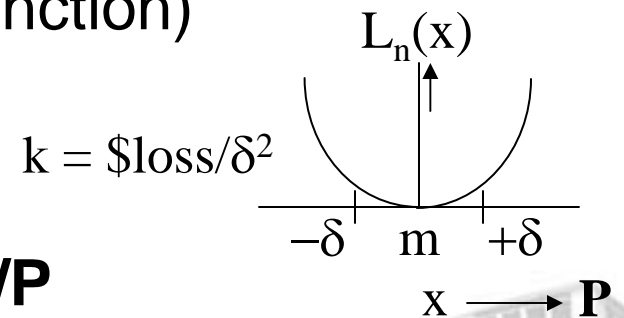
Applicable From of the Gap Analysis Equation

$$W(t) = V(t)Q(t) = \frac{\sum F(t)P(t)Q(t)}{I(t)}$$

Worth [per function(s)] = P/c/t * P/T * Q/P

Q = loss function, Minimum loss - $L_n(x)$

and $L_n(x) = k(x-m)^n$ (standard loss function)

$$L_n(x)$$

$$k = \$loss/\delta^2$$

$-\delta \quad m \quad +\delta$

$x \longrightarrow P$

For Research:
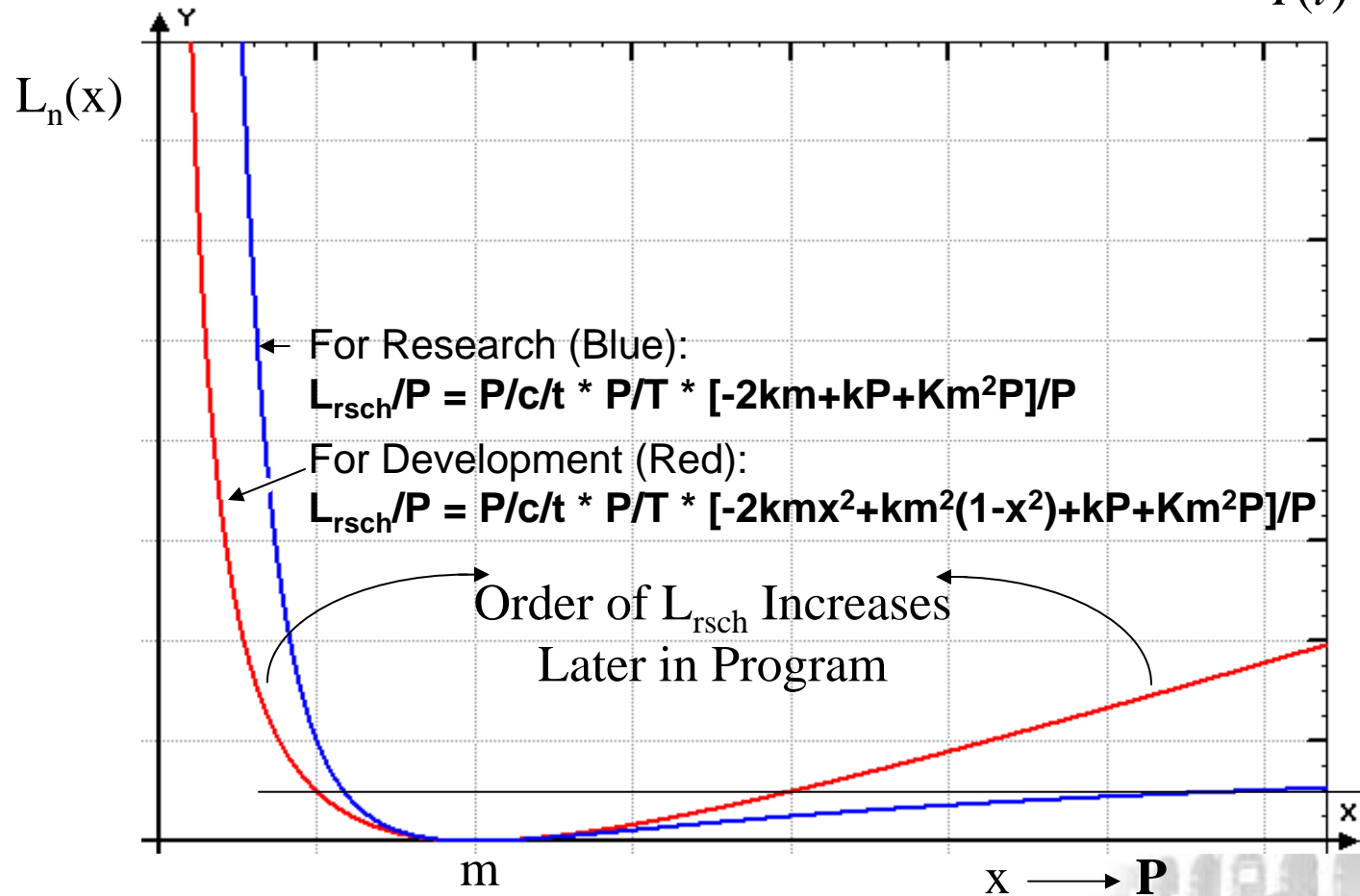
$Q_{rsch}/P = P/c/t * P/T * [2km-kP-Km^2P]/P$

For Development:

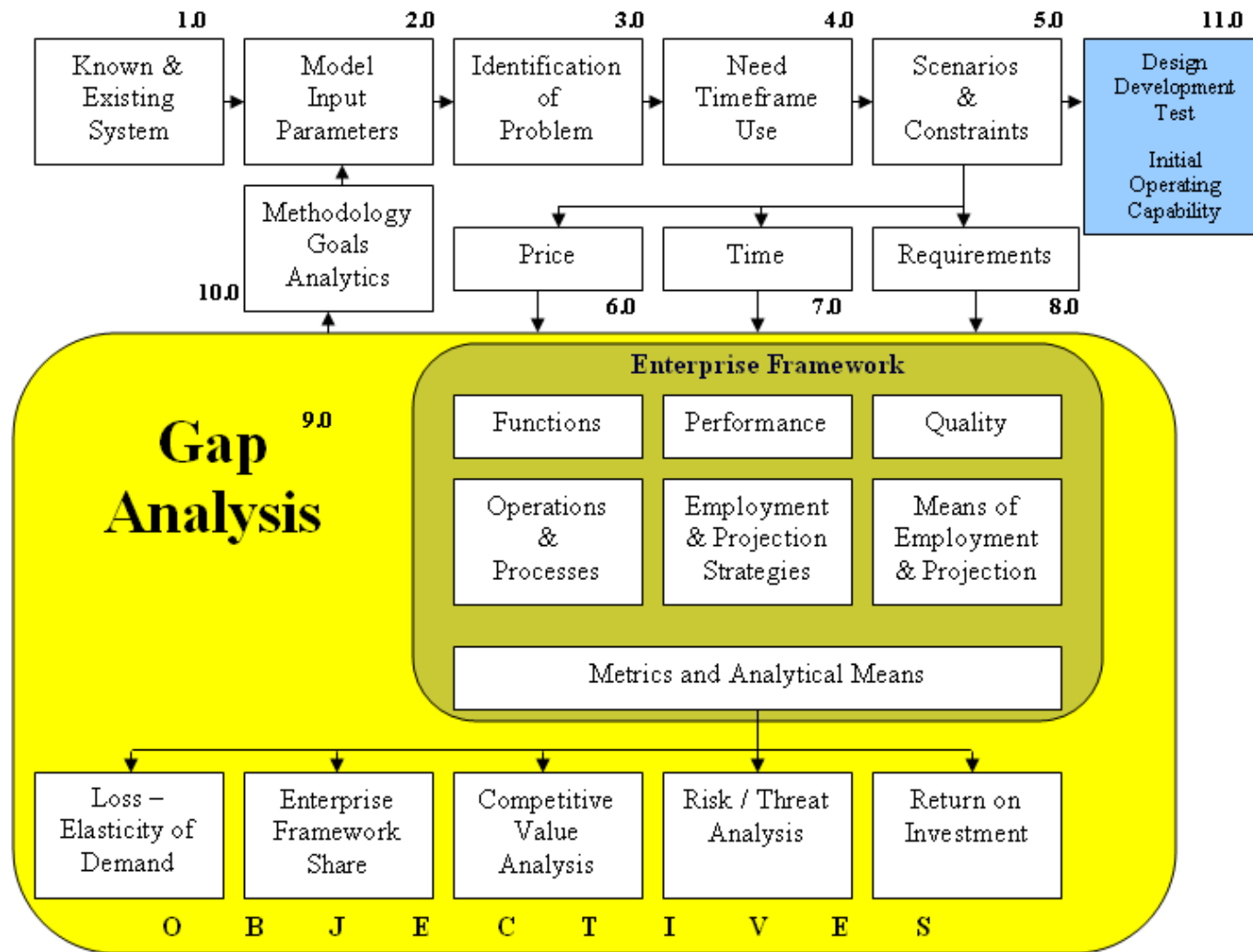**$Q_{devl}/P = P/c/t * P/T * [2kmx^2-km^2(1-x^2)-kP-Km^2P]/P$**

Applicable From of the Gap Analysis Equation

$$W(t) = V(t)Q(t) = \frac{\sum F(t)P(t)Q(t)}{I(t)}$$

$L_n(x)$

For Research (Blue):
$L_{rsch}/P = P/c/t * P/T * [-2km+kP+Km^2P]/P$

For Development (Red):
$L_{rsch}/P = P/c/t * P/T * [-2kmx^2+km^2(1-x^2)+kP+Km^2P]/P$

Order of L_{rsch} Increases
Later in Program

m

$x \longrightarrow P$

Gap Analysis: New, Improved, Robust

Gap Analysis Defines the Road and the Destination

Why Did The Chicken
Cross The Road ?

By Permission: Geoff & Jane Forster

Because it met the need.