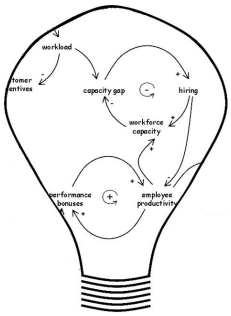
This course book preview is provided as an opportunity to see the quality of the course material and to help you determine if the course matches your needs. The preview is provided in a PDF form that cannot be printed.

It is my goal to provide a course book that is content-rich and that is useful as a reference document after the class has ended.

This preview shows selected pages that are representative of the entire course book. The pages shown are not consecutive. The page numbers as they appear in the actual course material are shown at the bottom of each page. All table-of-contents pages are included to illustrate all of the topics covered by the course.

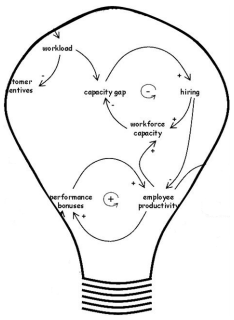
Dave Wells - dwells@infocentric.org



Business Analytics

for Insight and Foresight

TABLE OF CONTENTS

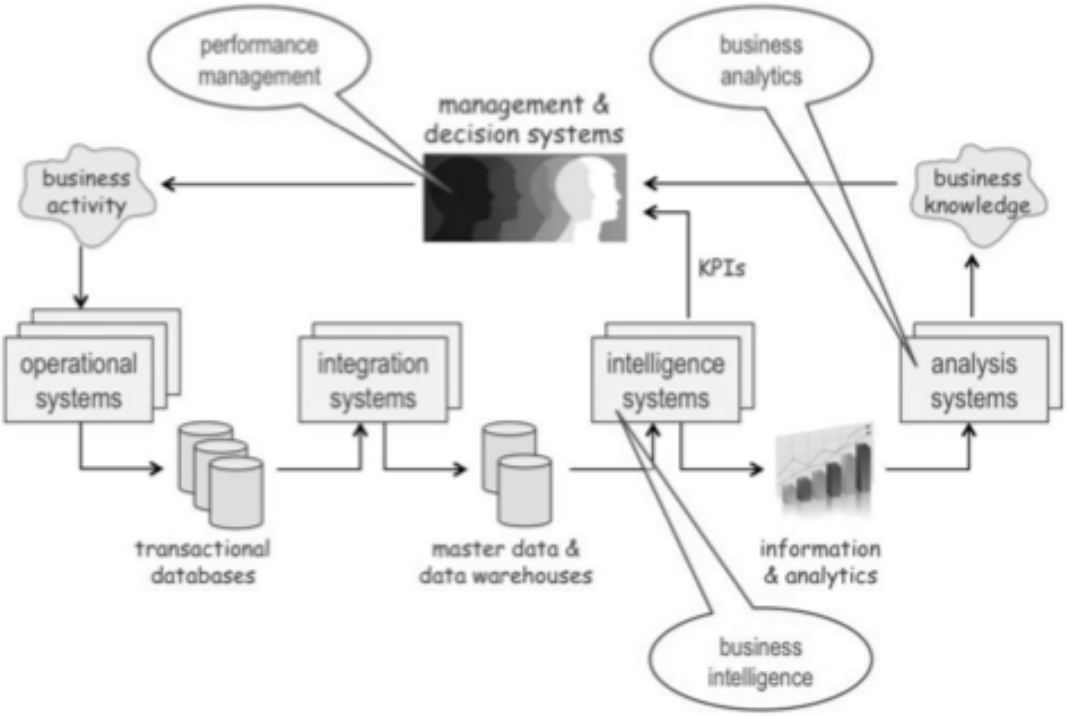


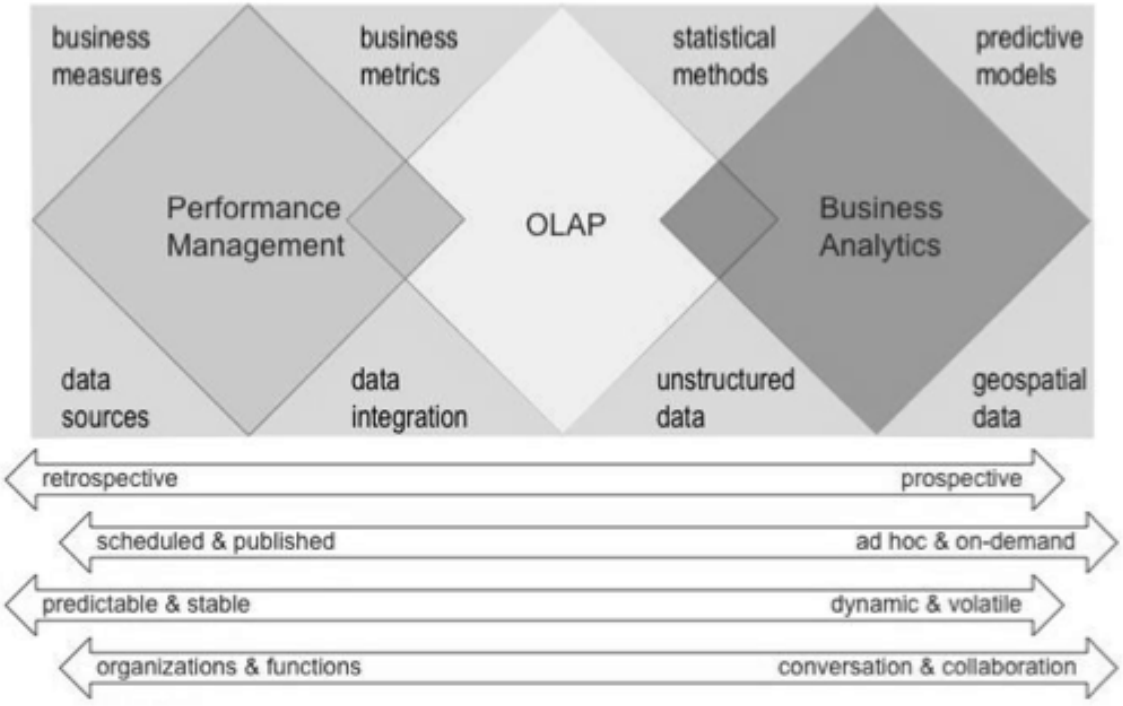
Module 1

Analytic Concepts

Business Analytics Concepts

Business Analytics vs. Business Intelligence





Business Analytics Concepts

Business Analytics vs. Business Intelligence

ANALYTICS AND INFORMATION FLOW

Let's begin to sort out the questions by examining where business analytics fit into a flow of business information. The diaGraham at the top of the facing page illustrates intelligence systems, which use data from master data and data warehouse sources to produce information and analytics.

ANALYTICS AND INFORMATION MANAGEMENT

Placing BA in context of other information management disciplines may help to clear the air. At the bottom of the facing page, BI is illustrated as a collection of interacting components. The key parts of the BI system include performance management, OLAP, and business analytics. Each is a discrete discipline, but performance management and BA both have some overlap with OLAP. Several other components – from source data to geospatial data, and from business measures to predictive models – combine to form BI systems.

WHAT IS THE ANALYTICS TO BI RELATIONSHIP?

From the perspective of information flow, BI and BA are overlapping fields. BI systems produce analytic information, which is examined by analytic systems. From the perspective of information management, BA is a component of BI. Both the Davenport and Harris view and the Wikipedia view have some merit. Davenport and Harris describe analytics strategically as part of an overall BI portfolio. Wikipedia describes analytics functionally as something that is distinct from but connected with BI.

ARE DASHBOARDS & SCORECARDS ANALYTICS?

WHAT ABOUT OLAP?

Dashboards and scorecards are simply ways to visualize and present business measures and metrics. They may be used to deliver measures and metrics that are derived through analytic processes, but are more commonly found in performance management applications. These technologies are better suited to the predictable and scheduled nature of performance management than to the on-demand and volatile nature of business analytics.

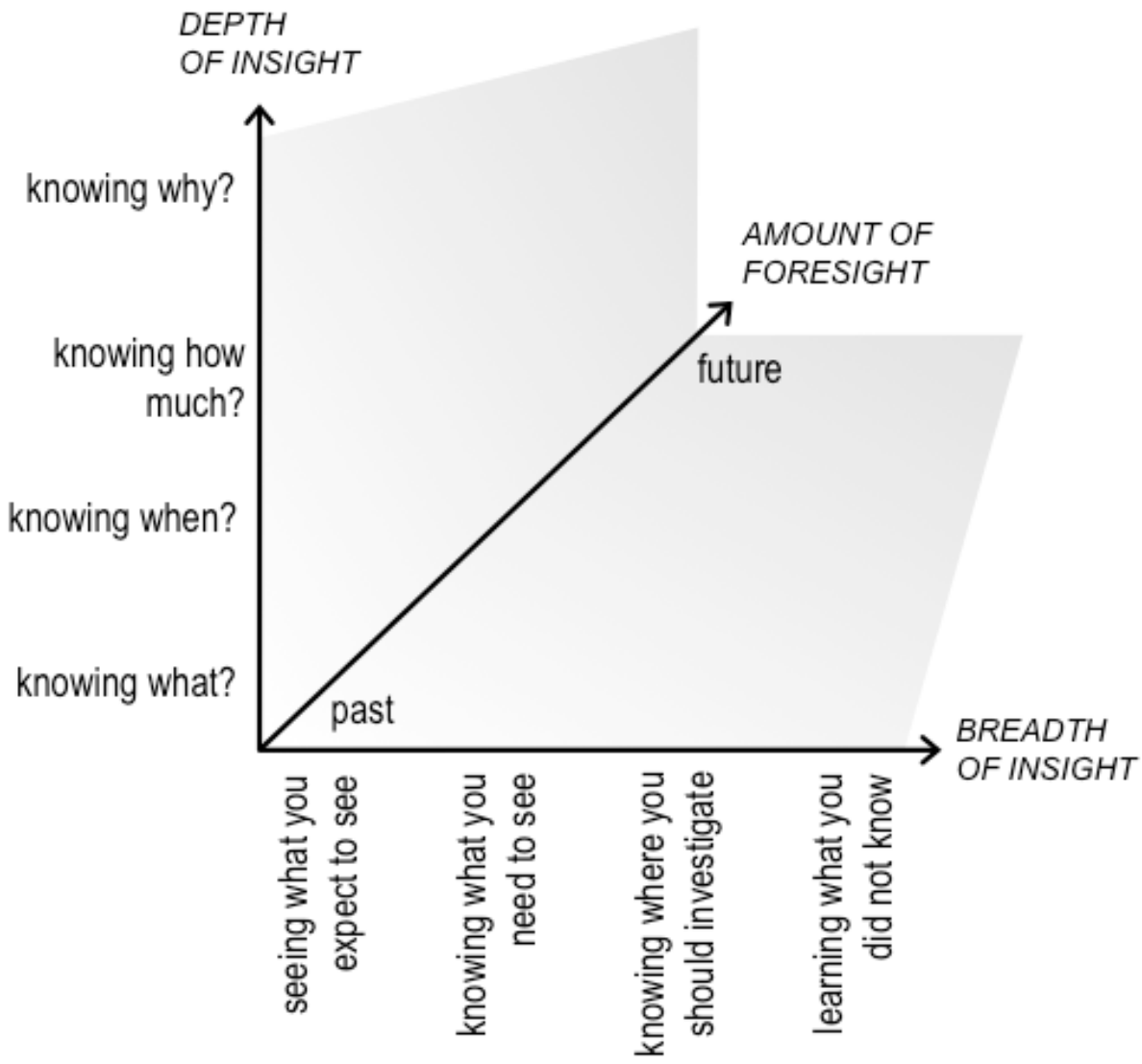
OLAP offers a bit more of the adaptability that analytics demand. Cubes may be good data sources and offer opportunities for data exploration. OLAP has a limited place in the business analytics toolset.

WHAT DISTINGUISHES ANALYTICS?

BA needs are more dynamic than the common metrics applications of performance management. Forward-looking analysis raises new questions as quickly as it answers current questions. The real value is derived not from the data, but from the conversations and ideas driven by looking at data. Wikipedia's definition captures some of the essence with the phrase "continuous iterative exploration." Good analytics processes are characterized largely by a sense of searching … of continuously seeking answers, understanding, insight, and foresight.

Business Analytics Concepts

The Role of Analytics in Business



Business Analytics Concepts

The Role of Analytics in Business

QUESTIONS AND ANSWERS

BA has two primary purposes – to answer questions and to generate new questions. But not all questions are equally difficult and not all answers are equally interesting. Consider, for example, the knowledge value of each of the following types of questions:

	knowing the …				
	Facts	Timing	Quantity	Causes	Choices
What?	✓				
When?		✓			
How much?			✓		
Why?				✓	
What If?					✓

UNDERSTANDING

The Merriam-Webster dictionary defines understanding as "the power to make experience intelligible by applying concepts and categories." In business context, facts and timing record experience as events, and quantification describes the magnitude of experience. Answering *what, when,* and *how much* provides the foundation for understanding.

INSIGHT

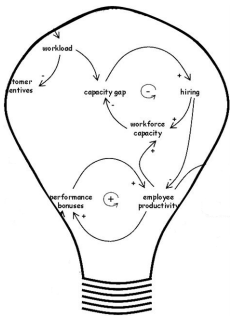
Insight is a clear and deep perception of a complex situation or condition – the ability to "see inside" the situation. Insightful analytics are those that create the ability to look inside deeply enough to understand the causes of a situation or condition. Insight builds on understanding, but requires that *why* questions are answered in addition to *what, when, and how much*.

FORESIGHT

Foresight is the ability to see into the future – to evaluate alternative courses of action and to forecast the probable outcomes of actions. Foresight builds on understanding and insight to by answering the "*what if*" questions.

LEARNING

High-impact analytics are those that enable learning. To make a real difference in business, analytics must help to discover that which is not yet known – to build new knowledge. When learning about the past and the present, you gain insight. When learning about the future you achieve foresight.



Module 2

Cause and Effect

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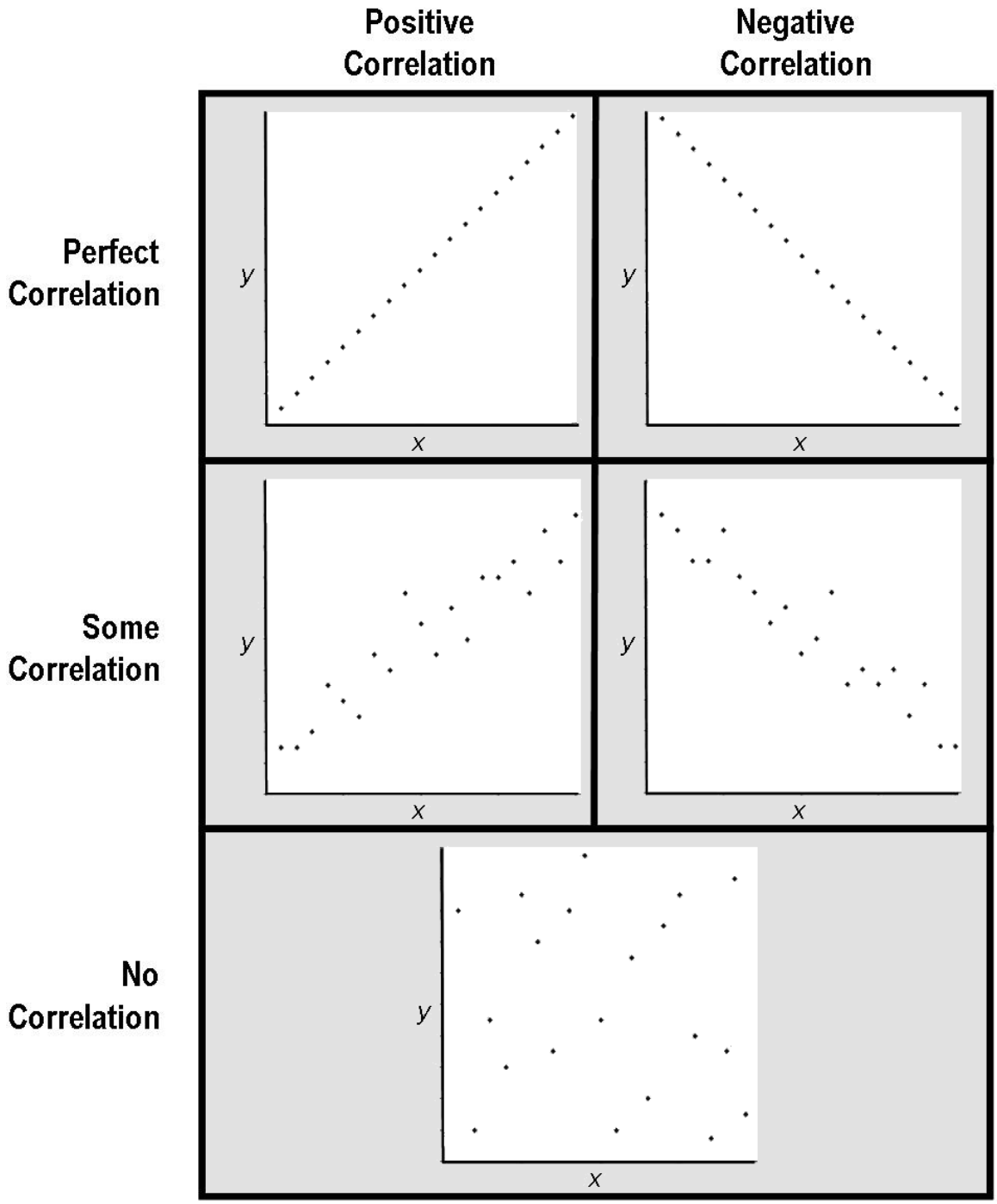
Cause and Effect Concepts

Definitions and Distinctions: Correlation



Cause and Effect Concepts

Definitions and Distinctions: Correlation

WHY STUDY CAUSE AND EFFECT?

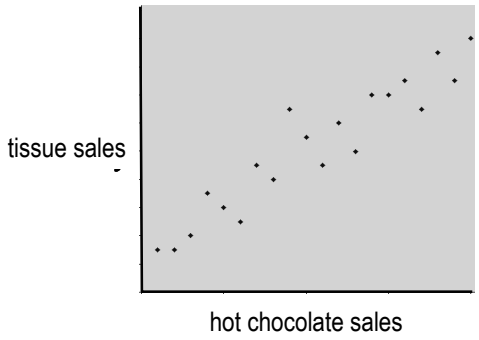
The essence of business analytics is to understand cause and effect relationships. This understanding is necessary if we are to deliver high-impact analytics that are purposeful, insightful, and actionable. The key to high-impact analytics is a strong connection with cause and effect – the path to knowing why things happen and deciding what to do about them.

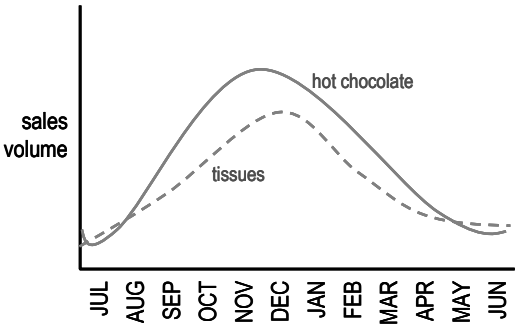
CORRELATION ANALYSIS

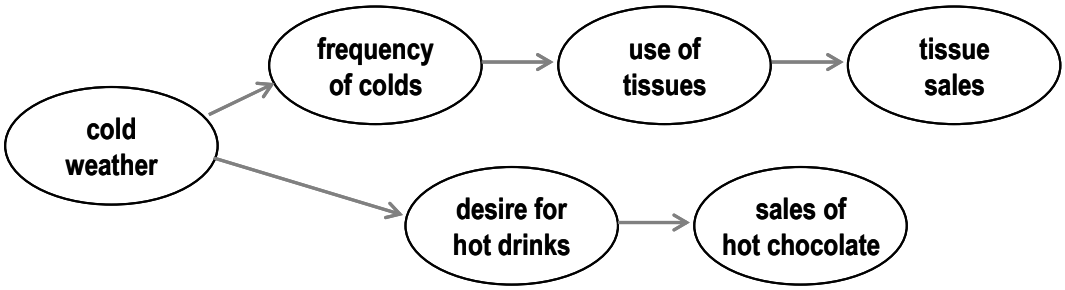
Much of the work of analytics is based on correlation – the strength and direction of a linear relationship between two variables. Correlation is measured as a correlation coefficient. The strongest positive correlation has a coefficient of +1.0 indicating a one-to-one correspondence between two variables whose values move in the same direction. The strongest negative correlation has a coefficient of -1.0 indicating a one-to-one correspondence between two variables whose values move in opposite directions. A correlation coefficient of zero indicates no correspondence of values between the two variables.

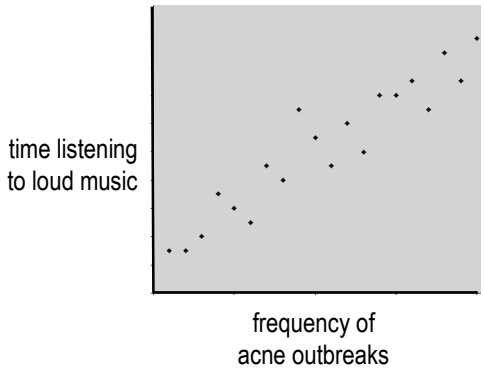
Cause and Effect Concepts

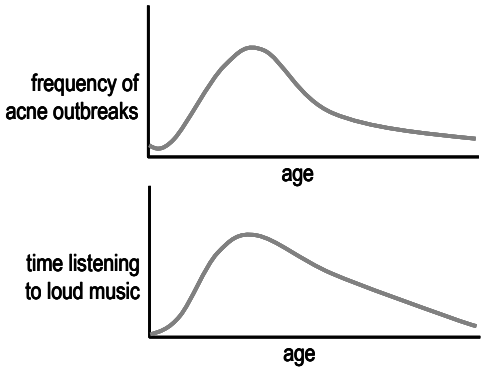
Definitions and Distinctions: Influence

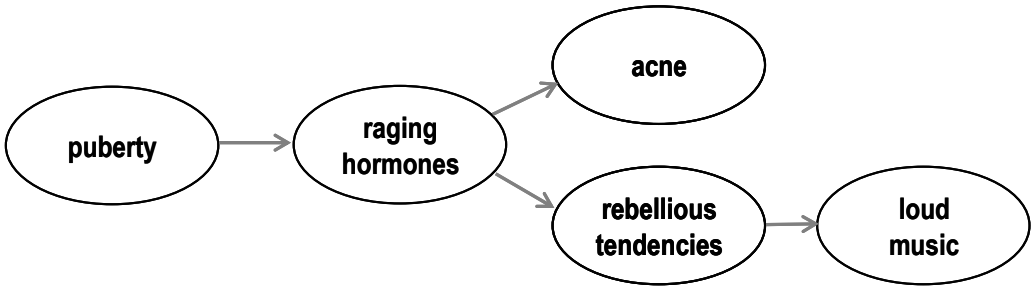












Cause and Effect Concepts

Definitions and Distinctions: Influence

WHY THINGS HAPPEN

Knowing why things happen is important. We must know why before we can know what to do about it, and before we can know what to expect in the future. Knowing why matters, and all too often we seek easy answers. But simple answers where complex relationships exist are often wrong answers:

- We confuse indicators with certainty,
- We confuse evidence with proof,
- We confuse influence with cause.

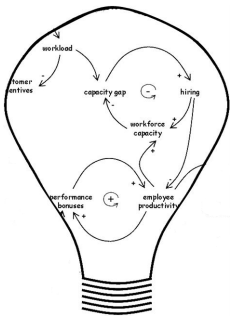
To really understand why things happen we must set aside the desire for certainty and proof, and we must understand that cause is the compound behavioral effect of many influences. Understanding influence is the key to knowing why.

WINTER, CHOCOLATE, AND TISSUES

Chocolate doesn't sell tissues, and tissues don't sell chocolate. Yet the two have strong positive correlation with a seasonal confounder. But we know that winter doesn't cause either tissues or chocolate. So let's shift our thinking a bit and consider winter not as a confounding variable, but as a source of influence. This line of thinking builds an influence chain – a cause-effect sequence – as illustrated at the top of the facing page. We're a step closer to understanding why. And we have introduced new and relevant variables – frequency of colds and desire for hot drinks – into the scope of analysis.

AGE, ACNE, AND MUSIC

Acne doesn't cause loud music, nor does loud music cause acne. And age doesn't cause either acne or loud music. Yet the three variables have some kind of influential relationships that bring about the correlations. The facing page illustrates one possible explanation of the causal relationships among these variables. In doing so, it introduces new variables – hormones and rebellion – that expand the scope of analysis.



Module 3

Analyzing Systems

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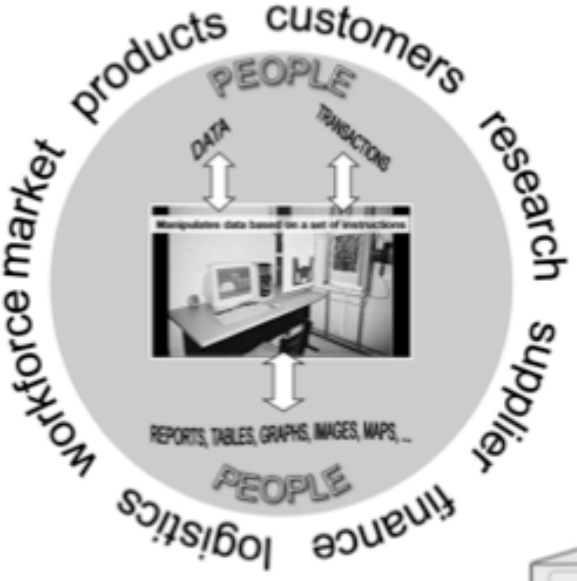
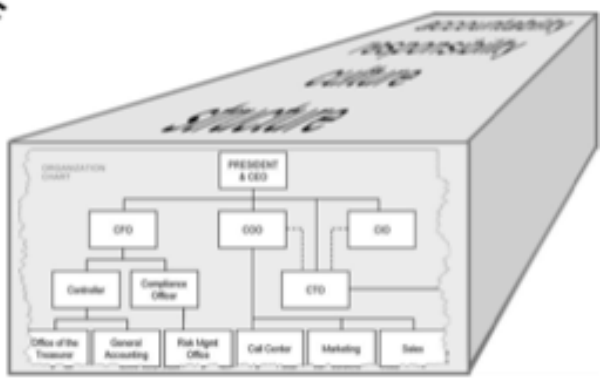
An Introduction to Systems Thinking

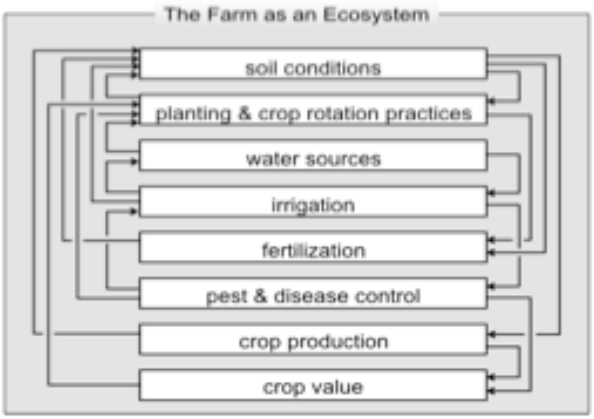
Kinds of Systems



computer, information, and business systems



human and, organizational systems



biological and ecological systems

electrical and, mechanical systems

An Introduction to Systems Thinking

Kinds of Systems

DIVERSITY OF SYSTEMS

When we hear the word "system" in today's business world, we typically think of computer systems, information systems, and business systems. And we certainly care about those kinds of systems. But many other kinds of systems exist in the world around us, and we can learn much about systems in general by observing diverse systems.

A system is defined as a collection of parts that interact to achieve a purpose. Some of the kinds of systems that we encounter (and are sometimes a part of) on a daily basis include computer, information, business, human, organizational, electrical, and mechanical systems.

DIFFERENCES AMONG DIVERSE SYSTEM TYPES

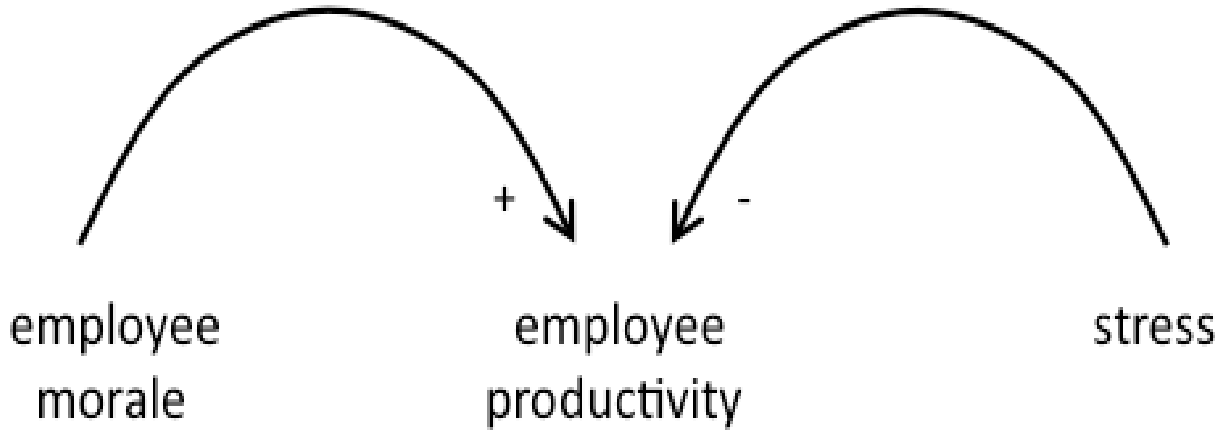
The things that differentiate these diverse kinds of systems are parts and purpose. The parts of a computer system, for example, are distinctly different from the parts of an organizational system. The parts of these two different kinds of systems interact in unique ways to satisfy their individual purposes.

SIMILIARITIES AMONG DIVERSE SYSTEM TYPES

Regardless of the type of system, however, they all have parts, interaction, and purpose. The interactions always take the form of one thing exerting influence upon another thing. Without fail, some sets of influences will cycle to create feedback loops. These basics – influence and feedback – are true of every system.

An Introduction to Systems Thinking

Influence



Same Direction Influence

- positive correlation of productivity with morale
- when morale increases productivity increases
- when morale decreases productivity decreases

Opposite Direction Influence

- negative correlation of productivity with stress
- when stress increases productivity decreases
- when stress decreases productivity increases

An Introduction to Systems Thinking

Influence

INFLUENCE AS A RELATIONSHIP

Influence is one form of relationship between the things in a system. The result of interaction among things is the degree to which that interaction affects the behaviors of each interacting part.

SAME DIRECTION INFLUENCE

Same Direction Influence is one of the behaviors of system interaction. This concept is also called additive influence.

Same direction influence in systems diagram is indicated using a "+" symbol, indicating a positive correlation coefficient for the relationship between the two things. Consider the influencing thing as an independent variable and the influenced thing as a dependent variable.

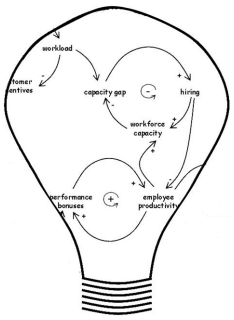
Positive correlation doesn't necessarily mean good influence. The example on the facing page shows positive correlation of employee morale and employee productivity. This diagram says that morale and productivity move in the same direction. When morale improves productivity also improves. When morale declines productivity also declines.

OPPOSITE DIRECTION INFLUENCE

Opposite Direction Influence is another of the behaviors of system interaction. This concept is also called subtractive influence.

Opposite direction influence in systems diagram is indicated using a "-" symbol, indicating a negative correlation coefficient for the relationship between the two things. Again, consider the influencing thing as an independent variable and the influenced thing as a dependent variable.

Negative correlation doesn't necessarily mean bad influence. The example on the facing page shows a negative correlation of stress and employee productivity. This diagram says that stress and productivity move in opposite directions. When stress decreases productivity improves. When stress increases productivity declines.



Module 4

Insight and Analytics

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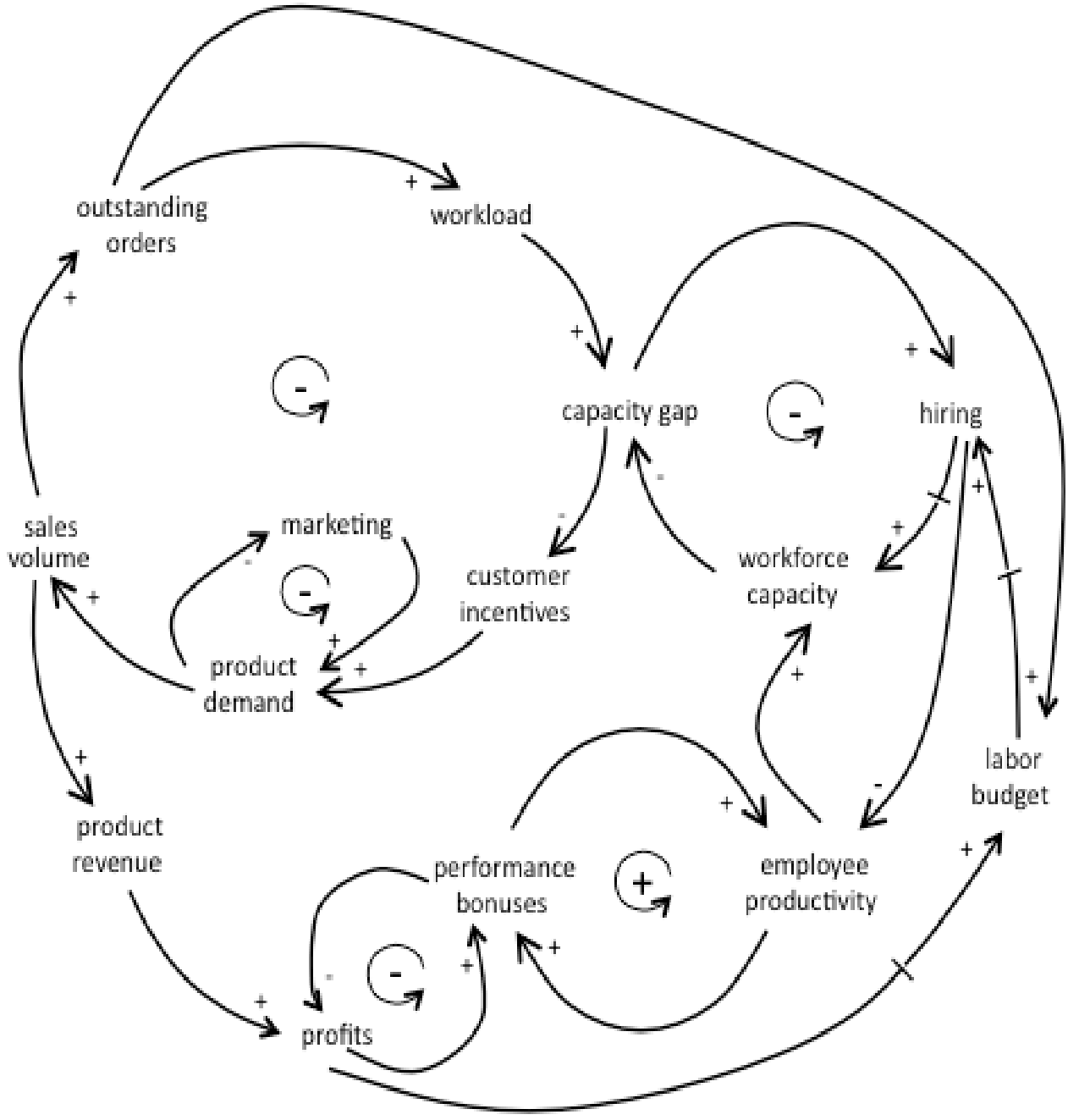
Seeking Insight in System Models

Discovery



Seeking Insight in System Models

Discovery

RETHINKING THE SYSTEM

The analysis of disparity and disconnect has produced insights and discovery about the nature of the system as it currently works and as it should work. But insight and discovery are useful only when they are applied to make a difference. It is time to reconstruct the system model – to create the *as-needed* model based on new knowledge.

Much of the discovery relates *workload* as a contributor to *capacity gap.* This is significant because *capacity gap* is the fundamental problem node – it defines the problem to be solved. There are only two ways to change *capacity gap:* through *workload* and through *workforce capacity.* Thus any opportunity to optimize *workload* management is valuable.

So let's explore the evolution of *workload* influences:

- The original model illustrates a balancing loop involving *workload → customer incentives → outstanding orders → workload …*
- Analysis of disconnects brings *capacity gap* into the loop.
- The new loop functions as *workload → capacity gap → customer incentives → outstanding orders → workload …*
- Analysis of disconnects finds that *sales volume* influences *outstanding orders,* suggesting that *sales volume* should be part of this loop.
- *Product demand* influences *sales volume* suggesting that demand may also have a role in this loop
- Disparity analysis finds that *marketing* influences *product demand,* and also participates in the loop in some way.
- Rethinking this portion of the system to produce an as-needed model results in two balancing loops:
  1. *workload → capacity gap → customer incentives → product demand → sales volume → outstanding orders → workload …*
  2. *product demand → marketing → product demand …*

The as-needed system is substantially different from the as-is system, especially in the area of *workload* and its influences. The shift from a balancing loop of three nodes to one of six nodes offers additional leverage points for workload management.

Seeking Insight in System Models

Archetypes

Systems Archetypes are generic causal loop models that represent recurrent patterns of behavior in systems. Balancing and reinforcing loops are the two most basic archetypes upon which more complex archetypes are constructed.

Accidental Adversaries

Drifting Goals

Escalation

Fixes that Fail

Growth & Underinvestment

Limits to Success

Shifting the Burden

Success to the Successful

Tragedy of the Commons

Seeking Insight in System Models

Archetypes

RECURRING PATTERNS OF BEHAVIOR

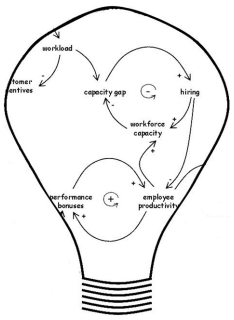
System archetypes provide yet another opportunity for insight through system models. Archetypes are abstract cause-and-effect structures that represent recurring patterns of system behavior. The patterns can be generalized across many different situations because the underlying relationships are fundamentally the same. Nine widely-recognized system archetypes are:

- Accidental Adversaries: Local optimization that is sub-optimal for the system as a whole.
- Drifting Goals: Lowering the bar; Closing a gap by reducing the desired state.
- Escalation: Competing for dominance; Goal setting based solely on competitor performance.
- Fixes that Fail: The high cost of quick fixes; Patches on top of patches.
- Limits to Success: Growth plateaus; Growth not sustainable due to market saturation or similar influences.
- Growth and Underinvestment: A special case of limits to success where the limits are self-imposed.
- Shifting the Burden: Fixing the symptom; A quick fix becomes the permanent state.
- Success to the Successful: Winners and losers; The rich get richer and the poor get poorer.
- Tragedy of the Commons: Shared resource overload; Overgrazing.

This quick overview serves only as an introduction to the archetypes. Each is described in greater detail in Appendix A of this book.

ARCHETYPICAL INSIGHT

Archetypes are a good source of insight specifically because they are recurring patterns. Knowledge of the archetypes helps you to see when these patterns exist in your own systems. The most vexing of problems and most counterintuitive of system behaviors are often a result of archetypical patterns. Archetypes help to explain why these kinds of problems and behaviors occur.



Module 5

Quantifying System Behaviors

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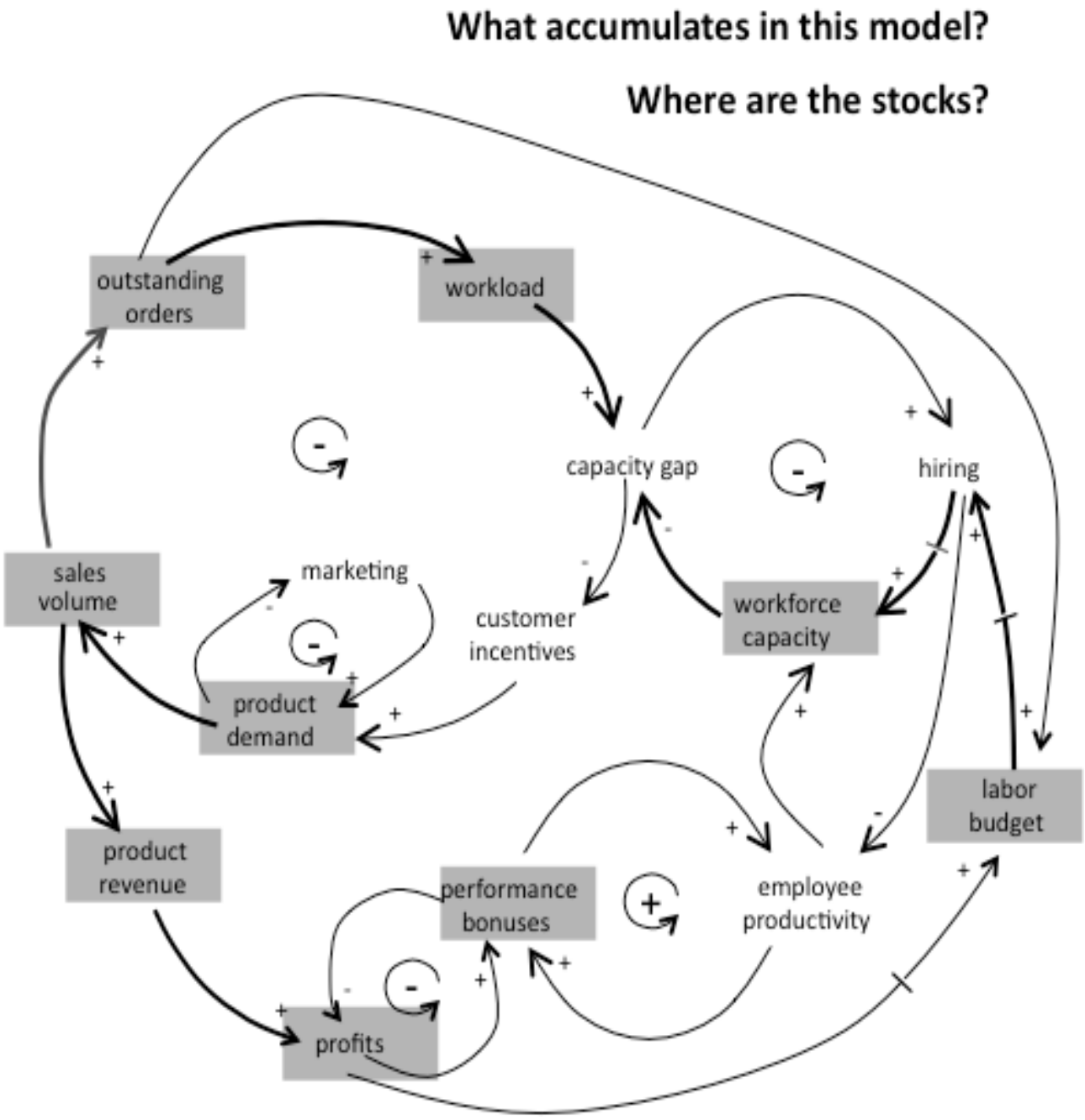
Modeling Stocks and Flows

Extending the System Model



Modeling Stocks and Flows

Extending the System Model

FROM CAUSAL LOOPS TO STOCK AND FLOW

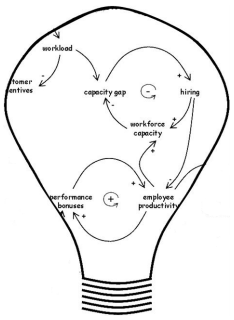
Stock and flow modeling is a technique that can be used to look more deeply into system behaviors than is possible with causal loop diagrams. Where causal loops are a qualitative look at system dynamics, stock and flow models are a quantitative view of the same dynamics.

Causal loop diagrams work well to understand the parts of a system and the interactions among those parts. The diagrams are simple and easily understood. CLDs serve well when you need to know what parts exist and how they interact. But they don't provide a means to quantify the things in a system or to quantify the influence of one thing upon another. Without quantities it is difficult to simulate system behaviors, to answer "what if" questions, and to achieve foresight.

Stock and flow models are, of necessity, more complex than causal loops. They are typically of narrower scope than a CLD and they collect more detail. The detail makes it practical to represent *what, why,* and *how much* in a single model.

FIND THE STOCKS

When examining a causal loop diagram, look at each node to determine whether the node represents something that accumulates in the system. Remember that stocks may be tangible or intangible – consumable or catalytic. Any node that satisfies these criteria may be considered to be a stock.



Module 6

Foresight and Analytics

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Simulating Behaviors

The Nature of Simulation

Predict: What does the future hold?

Forecast: How to shape the future? What path to take?

Simulate: How to explore various paths and see future possibilities?

Simulating Behaviors

The Nature of Simulation

PREDICTION vs. FORECASTING

Predictive analytics is a hot topic and an area of interest for many business analysts. It is important to distinguish between prediction and forecasting. The two methods are closely related but they answer distinctly different questions:

- Prediction answers the question *"What does the future hold?"* It attempts to provide credible and reasonably accurate answers about future outcomes.

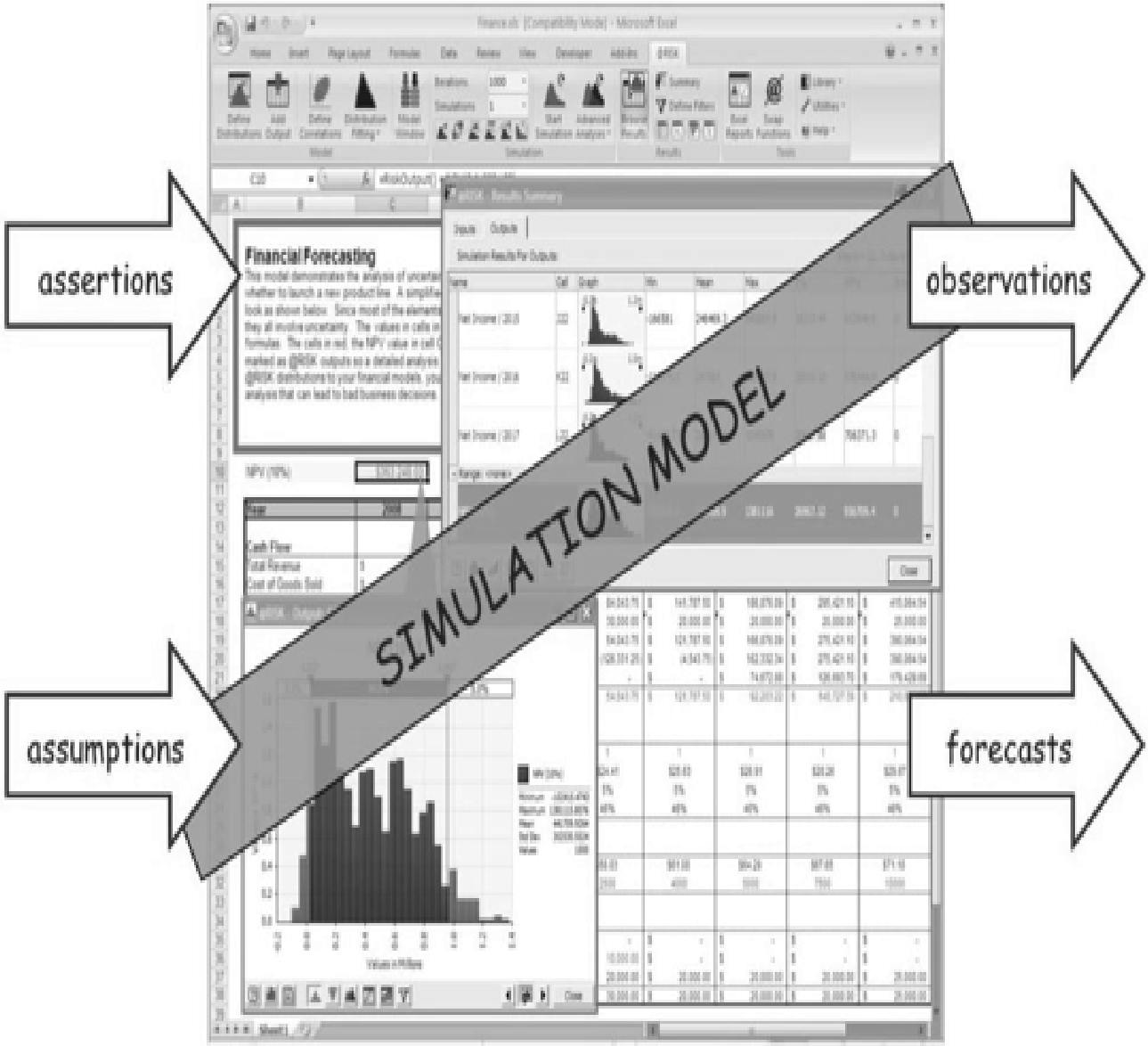
- Forecasting answers the questions *"How can I shape the future?"* and *"Which path should I follow?"* Forecasts attempt to provide reliable comparisons of future alternatives.

SIMULATION AND FORECASTING

Simulation is the fundamental technique upon which forecasting is based. The ability to simulate future behaviors for many different scenarios and to view the probable results of each scenario is the key to examining multiple alternatives and choosing the path most likely to lead to a desired future state. Simulation models make future possibilities become visible. Stock and flow models are the foundation for simulation models.

Simulating Behaviors

The Process of Simulation



Simulating Behaviors

The Process of Simulation

IMITATING BEHAVIOR

Simulation uses models to imitate system behavior and to forecast future outcomes. A typical model for simulation receives assertions (declared facts) and assumptions (hypotheses). The assertions and assumptions are processed through a collection of interactions – linkages of system components – to describe observations of system behavior and predictions of possible outcomes.

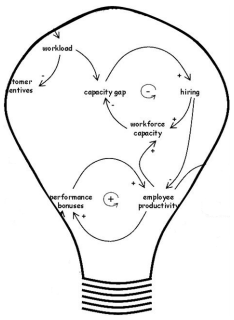
Common types of simulation models include:

- Steady-state models where the relationships between system components are defined as equations. The simulation system seeks to find a state where the system is in equilibrium. Steady-state models are best suited to simulation of physical systems.

- Dynamic simulation models accept changes to input signals (assertions and assumptions) to imitate behavior of changing conditions and circumstances.

- Stochastic models use random number generators to imitate chance and evaluate the effect of random events on system behavior. These models are also known as Monte Carlo simulations.

Stock and flow models are used in dynamic simulation. They are the basis to observe system dynamics – the response of a system to changing input variables.



Module 7

Summary and Conclusion

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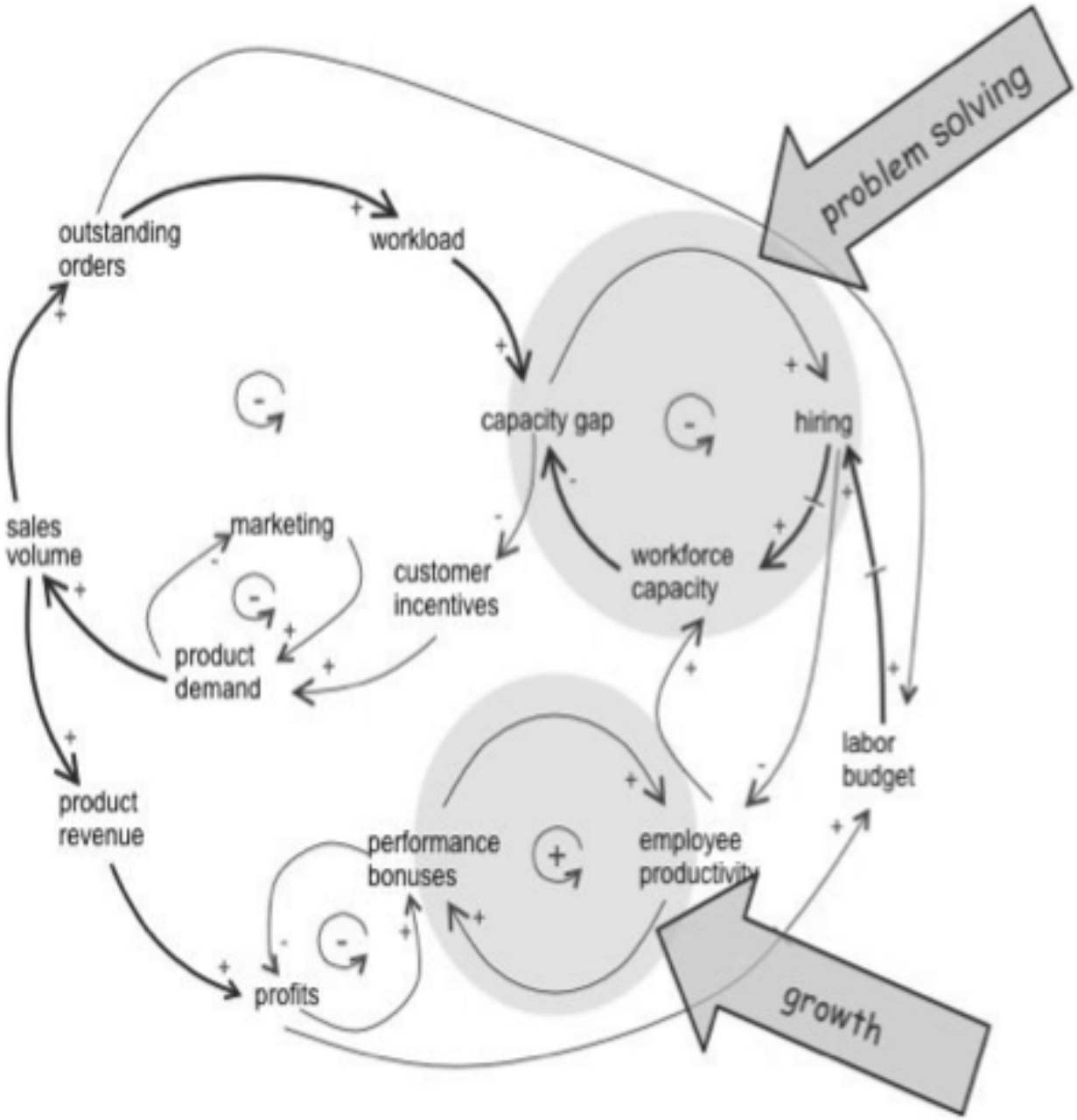
Purposeful and Actionable Analytics

Problem Solving vs. Growth



Purposeful and Actionable Analytics

Problem Solving vs. Growth

ANALYSIS FOR PROBLEM SOLVING

Balancing loops describe the system dynamics that need to be understood when your objective is one of problem solving -- goal seeking or correction. Balancing loops are, in fact, also known as goal-seeking loops.

When modeling system behaviors, begin with the business scope and context for the analytics. Within that scope, identify the variables of interest – those at which goals or correction are targeted – as the initial nodes of one or more balancing loops. As you study the system dynamics, the CLD will naturally extend to include reinforcing loops. The balancing loops are the starting place because they align with the stated objectives, but no system model is complete unless it has both balancing and reinforcing loops.

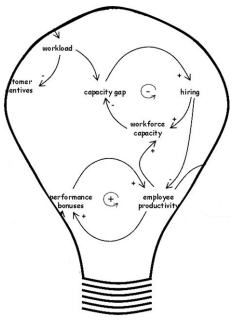
When using analytics for goal-seeking or correction purposes examine the CLD to find the balancing loops in which variables of interest participate as nodes. Assume, for example, that you are a business analyst viewing a graph that illustrates a disturbing pattern of behavior over time. The variables represented in the graph behave as they do because of the influences that affect them. These influences are found by examining the balancing loops in which they participate – the place where you'll find cause and effect. If you already have CLD's, then the job is half done. If not, then take the opportunity to start building a system model.

ANALYSIS FOR GROWTH PURSUIT

Reinforcing Loops describe the system dynamics that need to be understood when your objective is one of growth.

When modeling system behaviors, begin with the business scope and context for the analytics. Within that scope, identify the variables of interest – those at which growth targeted – as the initial nodes of one or more reinforcing loops. As you study the system dynamics, the CLD will naturally extend to include balancing loops. Reinforcing loops are the starting place because they align with the stated objectives, but no system model is complete unless it has both reinforcing and balancing loops.

When using analytics to understand growth, examine the CLD to find the reinforcing loops in which variables of interest participate as nodes. Assume once again, that you are a business analyst viewing a graph that illustrates a pattern of stalled or declining growth. The variables represented in the graph behave as they do because of the influences that affect them. These influences are found by examining the reinforcing loops in which they participate.



Appendix A

The System Archetypes

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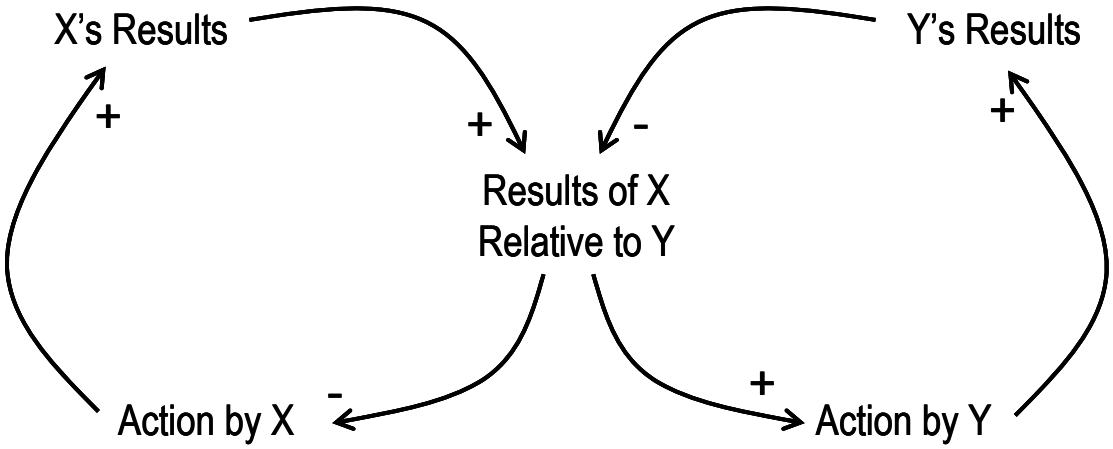
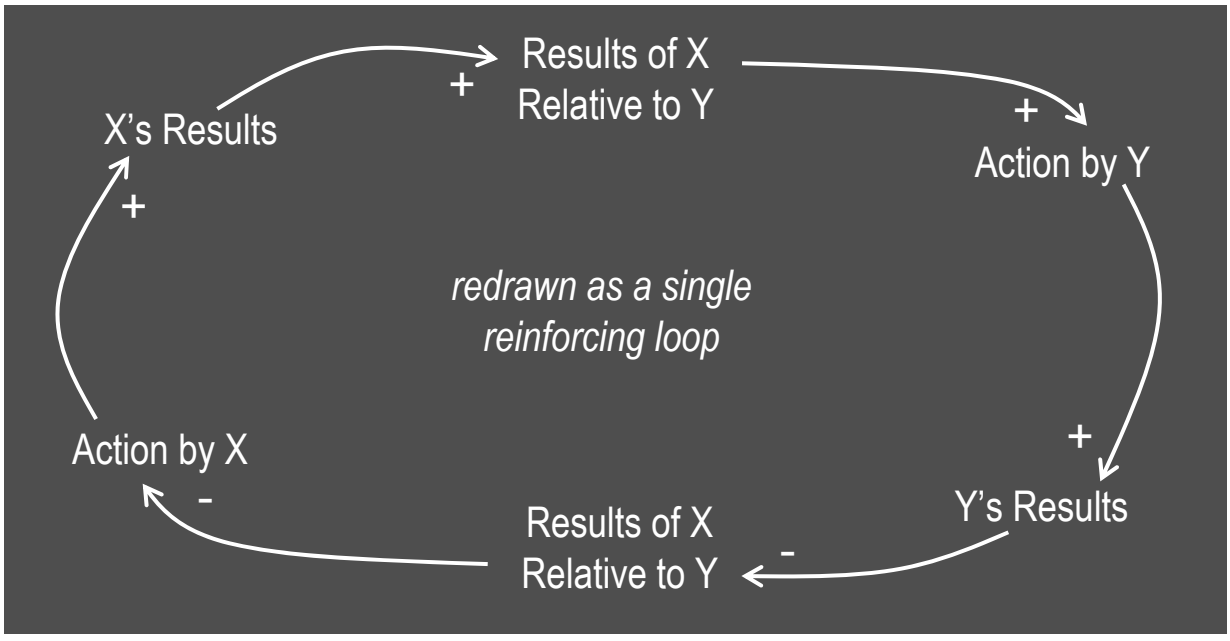
System Archetypes

Escalation





System Archetypes

Escalation

BEHAVIOR

Competing for dominance best describes the nature of the Escalation archetype.

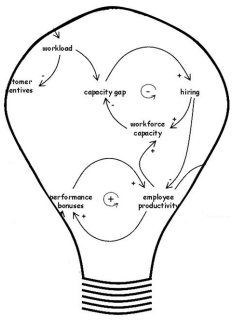
CHARACTERISTICS

- Two separate balancing loops exist, identified here as X and Y.
- The two loops intersect at a common gap which is defined as relative results.
- The results of action in each loop influence the desired state of the other.
- The results of action in each loop influence the drive for action in the other.
- The cycle repeats with no apparent end.

EXAMPLES

Socio-Cultural Example: The Cold War.

Consider the example of competitive pricing. It is common for retailers to advertise that they will match any competitor's price. What would be the eventual outcome if two retailers each established a policy of beating the other's best price by five percent? What solution can be applied to avoid that outcome?



Appendix C

Exercises

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Building a Causal Model

Exercise One

INSTRUCTIONS

The objective of this exercise is to develop a causal loop model for the problem or need that you have identified. Start by identifying one or more nodes that represent the problem or need. If the objective is growth you typically begin with one node that represents the growth subject. If the objective is balance expect three nodes that represent the desired state, the current state, and the gap.

Examine influences of the nodes in the model (what influences them?) and by the nodes in the model (what do they influence?) to iteratively expand the model with new nodes and links.

Consider these tips when modeling:

- ***Name Nodes with Nouns.*** The nodes represent things in a system and should be named using nouns. Avoid verbs, but don't hesitate to use enough qualifying words to make the meaning clear.
- ***Avoid Directional Ambiguity.*** Be sure that the nodes are named in a way that it make sense to talk about them increasing and decreasing. Verify that both nodes participating in a link are named in such a way that the meaning of "up" and "down" movement is clear.
- ***Name in the Positive.*** Use names for which the positive sense is preferable – for example "profit" instead of "loss."
- ***Explore Side Effects.*** Actively think about possible side effects of every influence that is shown in the model. Ask "what else might be influenced?" Then determine if the effect is significant in the scope of the model.
- ***Show Gaps and Goals.*** Every balancing loop has a goal that is represented as the desired state. Explicitly show the two states, the gap, and the external influences on the desired state.
- ***Think about Consequences Over Time.*** Consider both short term and long-term effects of each influence in the model. Think about any differences between perceived and actual states. Include delays in the model where they are needed.

Finding Insight in Your Causal Model

Exercise Two

INSTRUCTIONS

Examine the causal loop model that you developed in exercise one. You are specifically seeking insight – the ability to see inside the system and to discover things that you did not previously know.

Employ each of these concepts to find insight:

- ***Critical Thinking*** – Apply critical thinking skills to evaluate your model and to remove any bias or distortion. Check your assumptions and inferences.
- ***Disparity*** – Look for islands of activity and redundant nodes in the model.
- ***Disconnect*** – Seek missing influences and incorrect or illogical influences.
- ***Discovery*** – Use the findings from the model review thus far to distinguish between the way that the system does work and the way that the system should work.
- ***Rethinking*** – If necessary, develop a revised causal loop model that represents the "as needed" view of the system.
- ***Archetypes*** – Examine the model with the system archetypes in mind. Do you find examples of any of the archetypes in your system?
- ***Intensity*** – Examine the model to subjectively determine which of the links represent particularly strong influences in the system.
- ***Leverage*** – Use the model to identify places where system change or management change can make a difference in solving the problem or meeting the need stated as the intent of the modeling effort.