ACCELERATING INNOVATION

Creative Problem Solving In New Product Development, Existing Product Renovation, & Process Improvement

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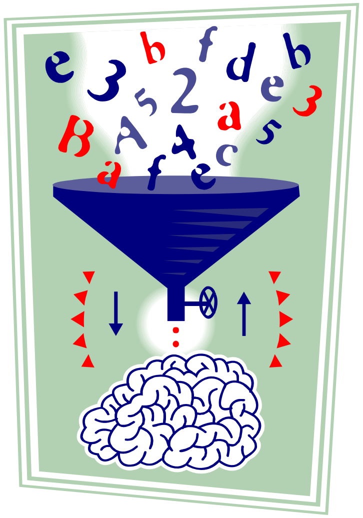
Innovation Success Factors

The Challenge of Leveraging KNOWLEDGE

Overcoming Myopia & Evaporation of Personal Experience



- Knowledge Myopia
  - Team members limited to personal experience
- Knowledge Extraction
  - So much data, so little time
- Experience Evaporation
  - Specialization: trend of knowing more about less
  - The Brain Drain: relocation, outsourcing, retiring workforce
- Results:
  - Re-inventing the wheel; rework; lost time & productivity
  - Overlooking “known” expertise & solutions

The Challenge of IDEATION

Overcoming Inertia and Capriciousness

- The Tyranny of Assumptions
  - “That’s Way Its Always Been…”
  - Constraints Implied by History, Technology, Culture, …
- Thinking Out of the Box
  - Psychological: Comfortable & Safe vs Radical & Risky
  - Technical: Considering Something You Don’t Know
  - Traditional Approaches Inconsistent
    - Scientific Method; Team Brainstorming; Lateral Thinking; Six Hats
- Results: Idea Flow & Quality are Unpredictable
  - Wing-&-a-Prayer, Blue Sky
  - Hit-or-Miss, Seat of Your Pants

How Can Automation Help Innovate?

Through Functional Abstraction & Semantic Retrieval

Function Modeling

- Broadens the scope of solution thinking by expressing requirements in a functional language that is conceptual & generalized

Semantic Indexing, Navigation & Natural Language Retrieval

- Finds solutions from internal & external technical knowledge sources

Abstraction of problem → Conceptual solutions

User's specific problem → Abstraction of problem

Conceptual solutions → User's specific solution

How Is Ideation Typically Done?

The Traditional 'Scientific Method'

- **Mostly: manual, informal, and only marginally helpful**
- **The Engineering Problem-Solving Cycle (Dartmouth College)**

Try to understand the problem
- Original problem statement
- Redefine the problem
- Identify constraints & develop general specification

Hope you get lucky
- Brainstorm alternatives
- Select most viable alternative

See if it works! Otherwise, repeat your steps until you do find something
- Check problem definition
- Refine and add specifications
- Brainstorm again if necessary
- Reiterate until problem is appropriately solved

Challenges with these approaches:
- **They tell you WHAT, but not HOW**

- **The Engineering Method (Ohio State University)**

Try to understand the problem
- Recognize and understand the problem
- Gather data (and verify its accuracy)
- Select guiding theories and principles

Hope you get lucky
- Make assumptions when necessary
- Solve the problem

See if it works!
- Verify the results
- Present the solution

Manual Brainstorming is little more than 'voodoo innovation'

Systematic Innovation

Overcoming Ideation Inertia and Capriciousness

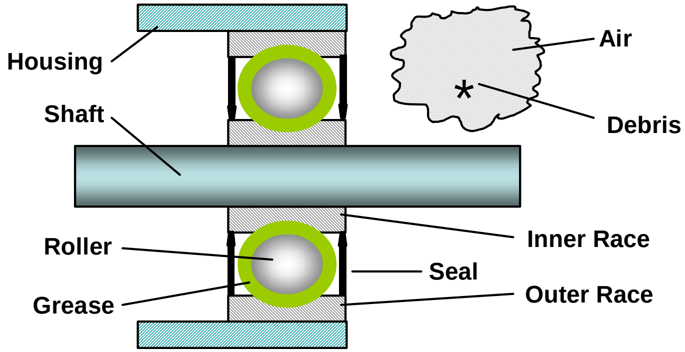
- When inventions (patents) are generalized, we find:
  - Innovative solutions often resolve technical contradictions
  - The same limited number of inventive principles are used repeatedly
  - Technical systems evolve towards ideality along predictable patterns
  - Most fundamental technical tasks have already been solved
    - Solutions exists for most problems, often in other disciplines or contexts
  - These trends are not recognized by individual inventors & their industries due to specific jargon and terminology
- Sixty Years of Value Engineering tells us:
  - The more abstractly we define the function of what we are trying to accomplish, the more opportunities we will have for divergent thinking
  - A high level of abstraction can be achieved by describing what is to be accomplished with a simple verb and noun
- By applying these observations, inventiveness and creativity can be taught, and can be systematized and accelerated thru automation

Function Modeling

Think Relationally, Think Functionally

- Captures system behavior (pro & con) and desired outcomes in simple verb-noun phrases
- Achieves the abstraction needed for divergent thinking
- Provides a common language for communicating design intent among disparate communities and life-cycle phases
- Automation of 'Ideality Methodologies" (such as TRIZ & VA/VE) can suggest alternative, even radical, design configurations

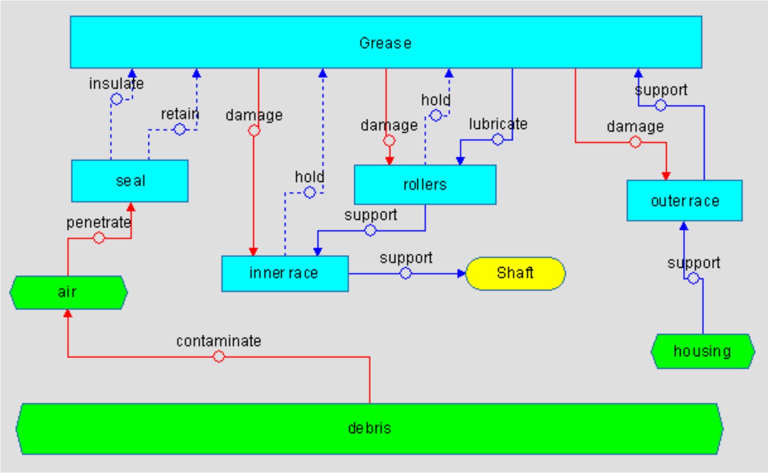
2-D Physical Model



ROLLER

BEARING

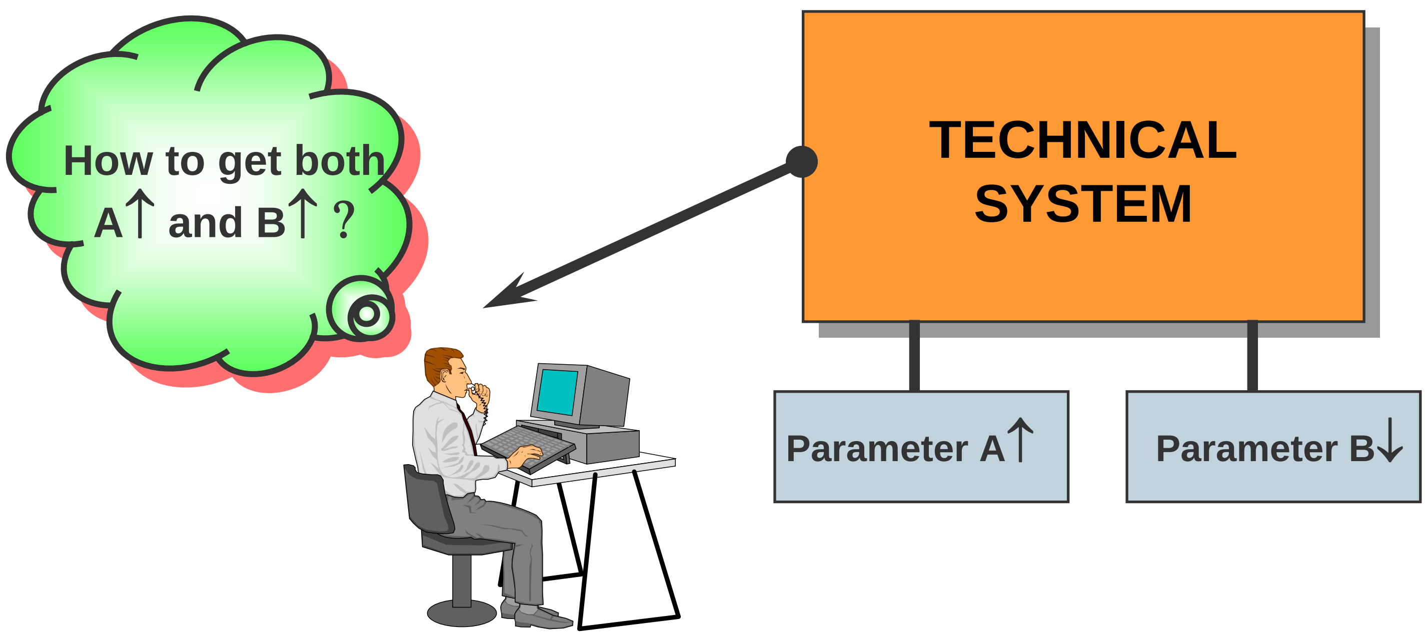
Abstract Function Model



Contradictions

The bane of technical systems

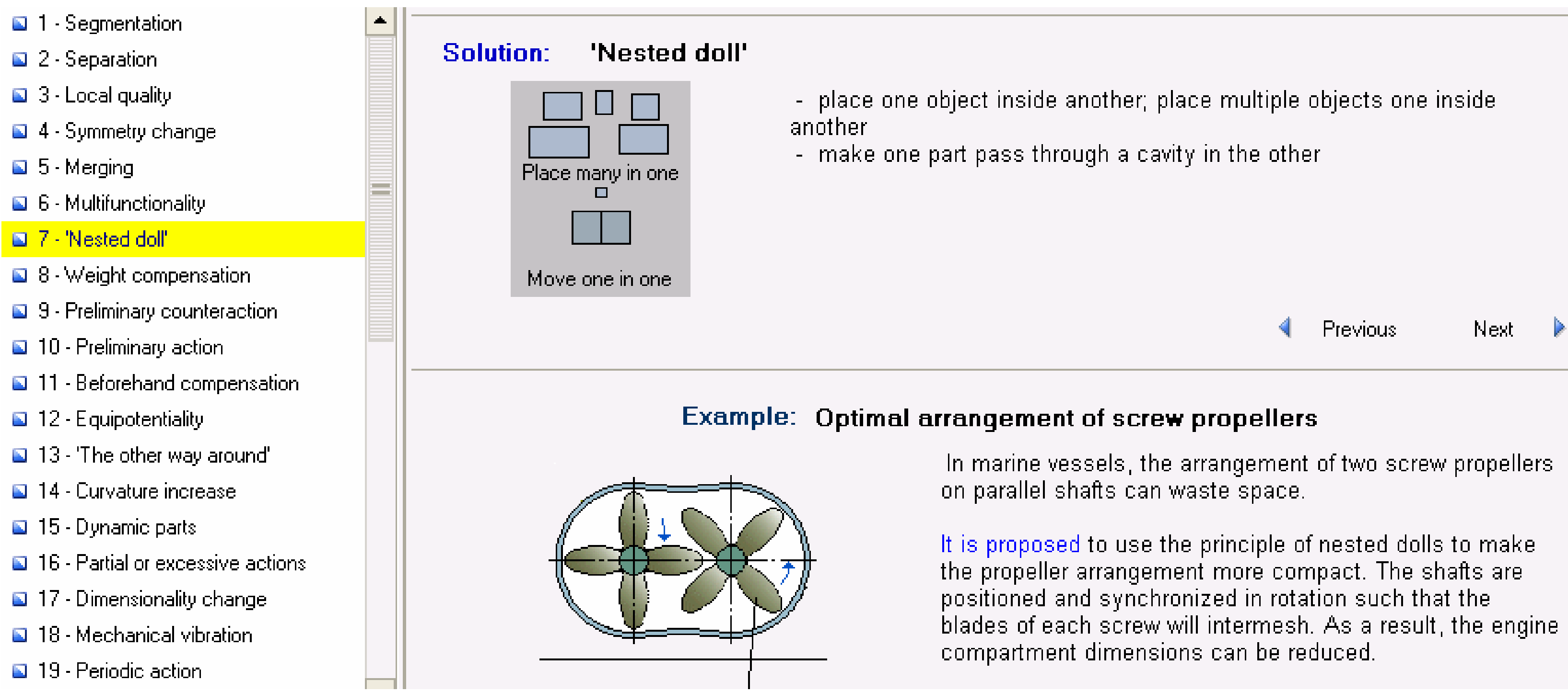
- **Technical Contradiction** - A situation when an improvement to one part (parameter) of a system leads to the deterioration of another part (parameter)
- **Physical Contradiction** - when a single parameter must simultaneously have different values (for example, the temperature of an object must be both high and low)



Library of Inventive Principles

How has this class of problem been solved before?

- Abstract rules for the creative resolution of constraints and contradictions in complex systems

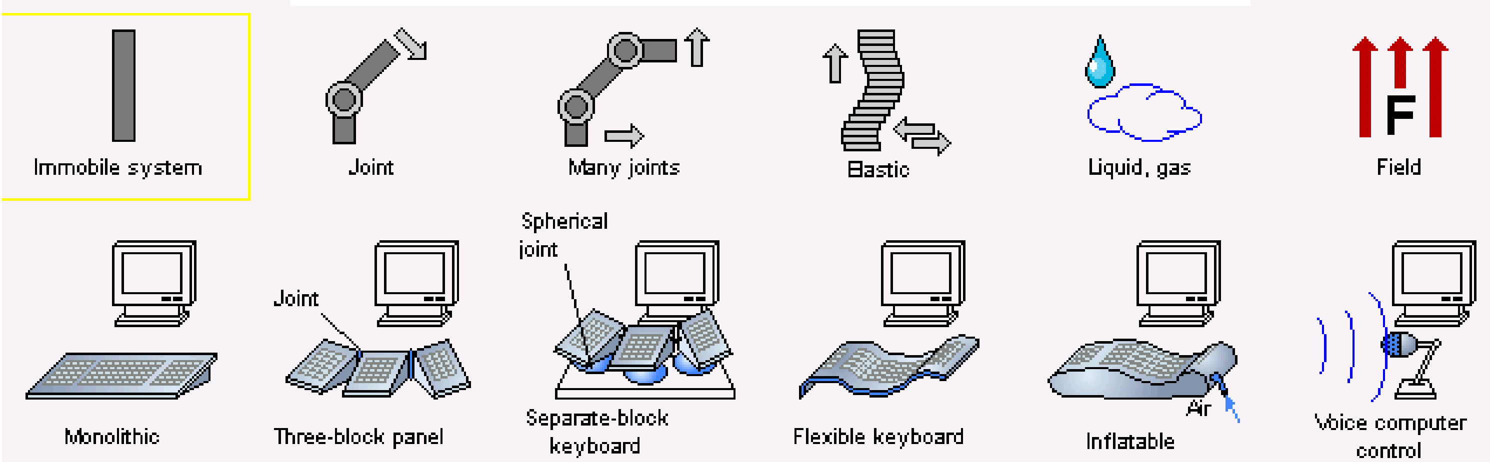


Library of System Modification Patterns

Are there new ways to implement this function/system?

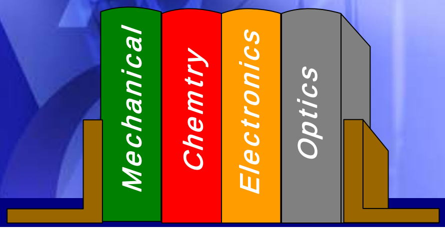
- Guidelines to predict possible trends of evolution for technical systems or classes of technology
- At a micro-level, suggests new approaches to performing a function

Example: Law of Dynamism, illustrated by Computer Keyboard



Scientific Effects Database

An Encyclopedia of Technical Phenomena



How many ways can YOU think of to "MOVE A LIQUID"?

Electrically charged aerosol
Electro-osmotic drying
Electroosmotic flow
Electro-osmotic pump
Electro-osmotic water removal
Electrostatic Induction
Electrostatic spray nozzle
Evaporation
Expander shuts fluid off
Extruder Head
Ferrofluidic electric generator
Ferromagnetism
Fire Suppression Air Foam
Fluid distribution - Capillaries
Fluids conveying
Formation of Liquid jet
Free Convection
Funnel Effect
Glue Roller - Porous solid
Head for Liquid supply

Airlift Effect
Archimedes Principle
Artificial gravity
Bernoulli's Theorem
Capillary effect
Capillary Pressure
Centrifugal Force
Closed Cooling System
Concrete Section Transport
Condensation
Conic Capillary Effect
Continuous use of Seawater
Control over presence of oil
Convection
Cooling system of nuclear reactor
Deformation of elastic body
Device for condensation
Displacing liquid from pump
Efficiency increase of mechanism
Electric contact using porous solid

Heat exchanger
Heat Transport System
Humidifier solid
Hydraulic Driven Pipe
Hydraulic Shock
Impregnation of porous body
Improved liquid penetration
Inertia
Ink drop trajectory change
Ink jet printhead
Liquid collection from water table
Liquid Evaporation II
Liquid mixing device
Liquid removal chemical materials
Longitudinal ultrasonic oscillations
Lorentz force
Magnetic attraction
Magnetic fluid accelerometer
Magnetic Fluid droplet optical switch
Magnetofluidic recording

Organize it by FUNCTION !!!!

- Fields : Absorb
- Fields : Accumulate
- Fields : Concentrate
- Fields : Detect
- Fields : Prevent
- Fields : Produce
- Parameters : Change
- Parameters : Measure
- Parameters : Stabilize
- Substance : Absorb/Adsorb
- Substance : Accumulate
- Substance : Clean
- Substance : Combine
- Substance : Concentrate
- Substance : Cool
- Substance : Deposit
- Substance : Detect
- Substance : Eliminate
- Substance : Form
- Substance : Heat
- Substance : Move
- Substance : Phase Change
- Substance : Prevent
- Substance : Produce
- Substance : Remove
- Substance : Separate

Question: How can you access phenomena outside your field of expertise?

Precision in Knowledge Retrieval

Need to Find Answers not a List of Suspect Documents

- Engineers cannot easily access solutions outside their division, across the company, outside their firewall, industry and domain expertise
- Knowledge workers spend 35% of their productive time searching for information online, while 40% of the corporate users report they cannot find the information they need to do their jobs on their intranets.
- IDC reports: unstructured text in large corporations doubles every two months and Fortune 500 companies lose billions in revenue due to cumbersome knowledge-seeking practices
- Search technologies return unmanageable quantities of documents
- Engineering organizations must stop reinventing the wheel

Knowledge-Based Innovation

Overcoming Knowledge Myopia & Experience Evaporation

- “The most successful innovators have structural processes in place to systematically organize and provide broad access to information resources and expertise. …..

- By codifying an employee’s experience, judgment and insight into explicit form, it becomes usable by others.”

- *Best Practices for Knowledge-Based Innovation*

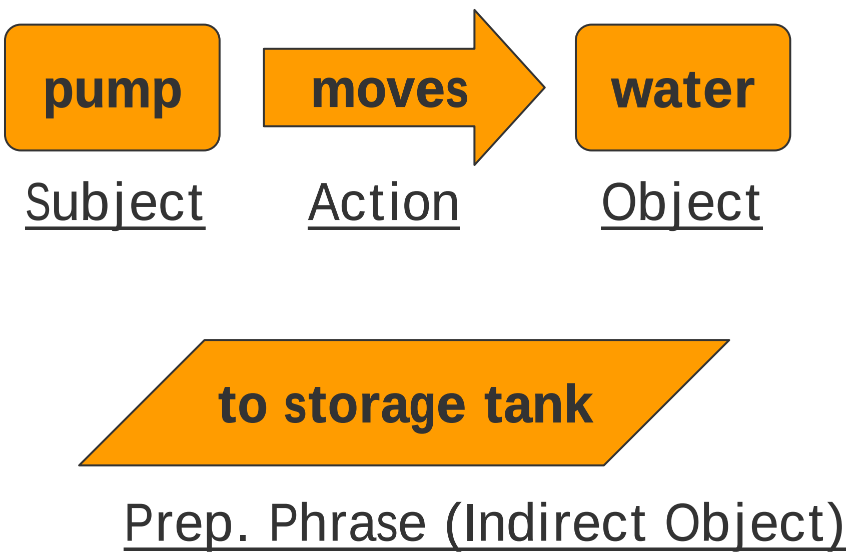
Gartner Research

Concept Retrieval via Semantic Technology

Concept retrieval requires extraction of deep semantic relationships

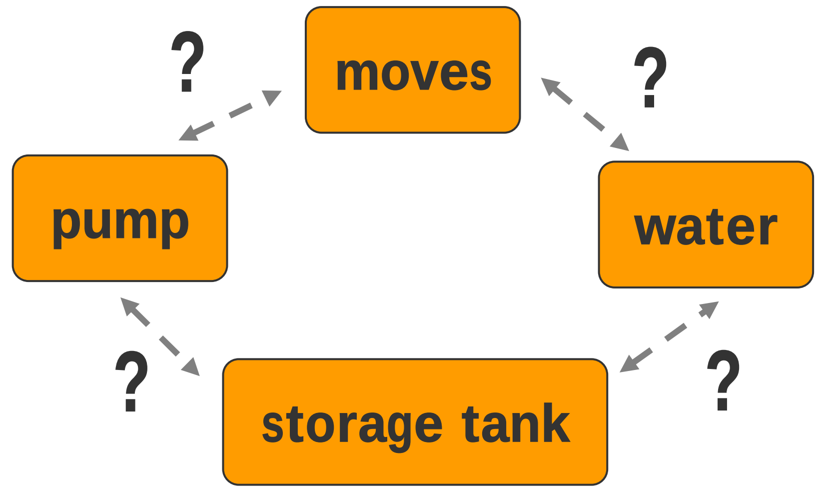
<u>Semantic Processing</u>

Extracts underlying meaning



<u>Keyword Processing</u>

Without full syntactic and semantic analysis, traditional keyword processing creates a simple bag of noun phrases - you never know the relationships between phrases or parts of speech.



Deep Semantic Structure

Many Phrases Have Equivalent Meanings

"Sucrose reduces the viscosity of soap 20% to 99%."

"The viscosity of soap can be reduced 20% to 99% by sucrose."

- Semantic processing captures the "meaning fingerprints" of sentences & phrases

Subject	Action	Object
sucrose	reduce	viscosity of soap

- What Natural Language queries will find this functional relationship?

A range of queries can match the semantic fingerprint of the example

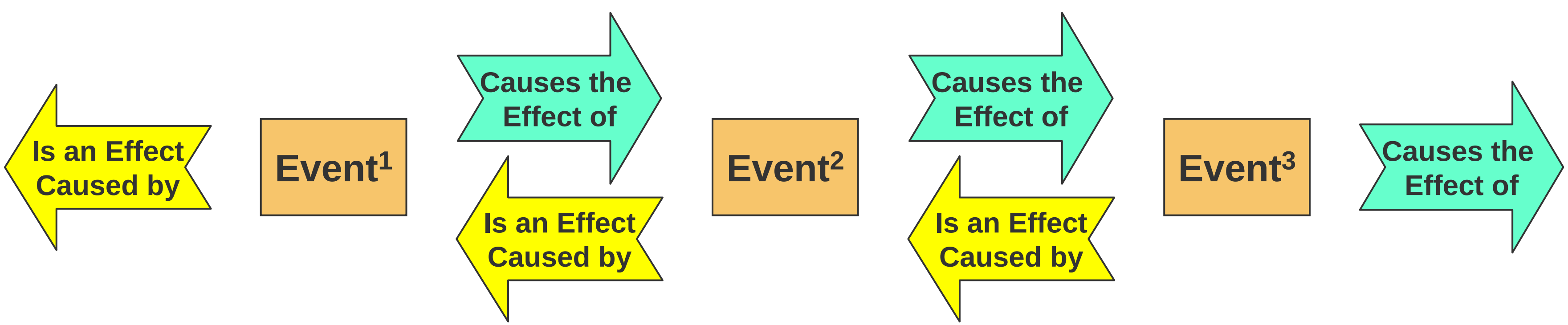
User query…	Subject “sucrose”	Action “reduce”	Object “viscosity of soap”
1) What reduces the viscosity of soap?	?	Yes	Yes

Causes & Effects

A Specific Category of Semantically Extracted Concepts

- Causes & Effects describe an event's **Why** and **So-What**

- Every event has its causes and its effects, depending on your perspective

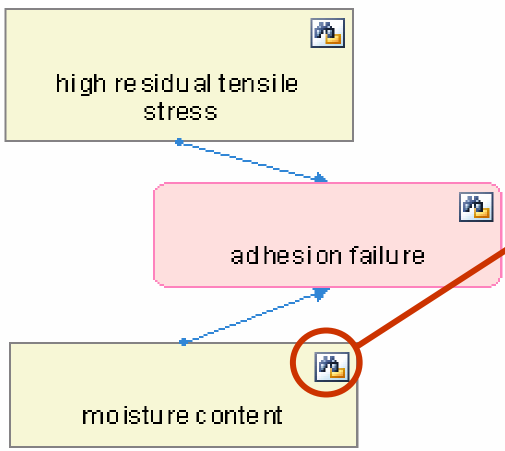


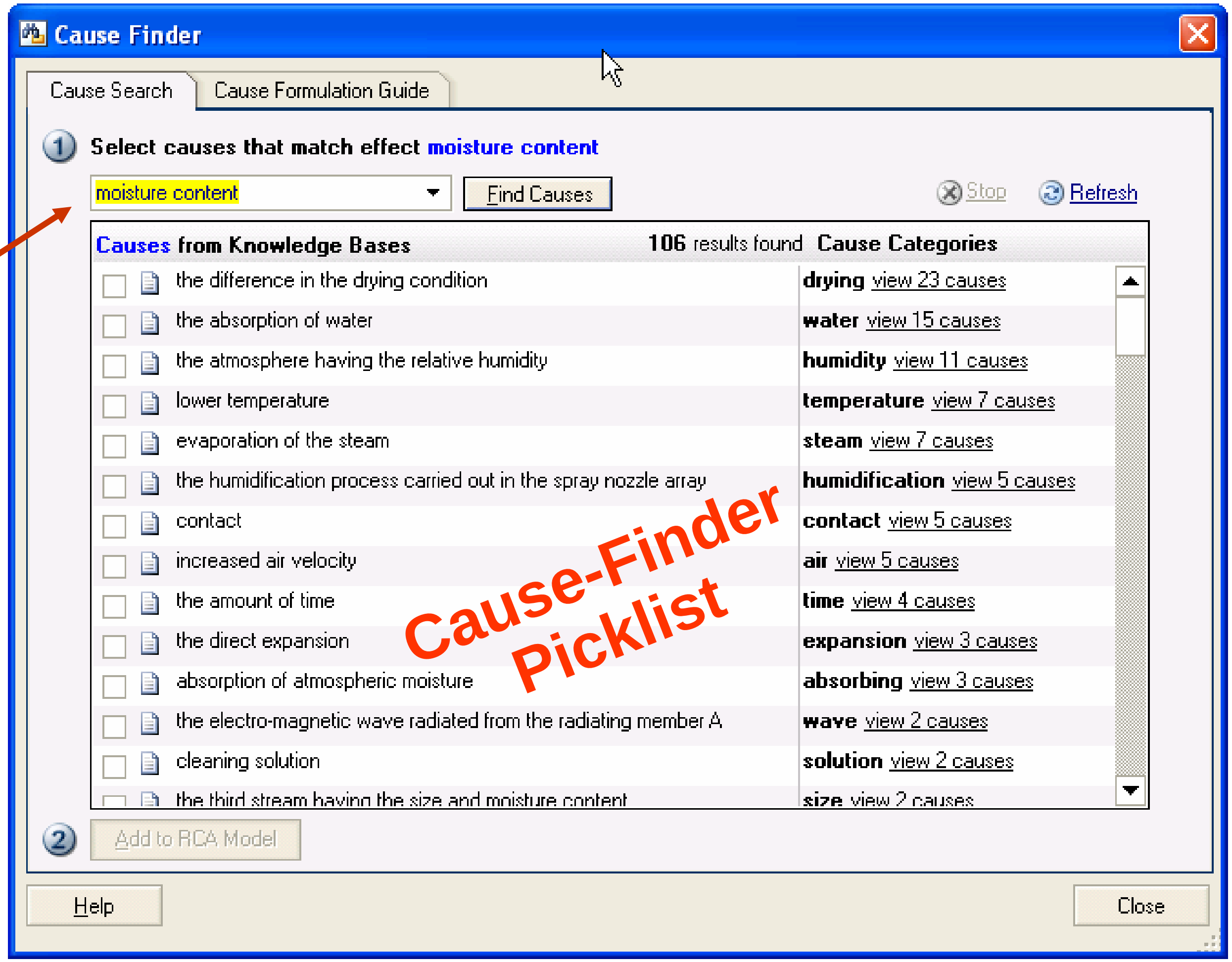
Why is this so important? Because …

- You can't deliver a great product without a great understanding of:
  - The causes that impact & affect a product's components & functions
  - The effects that a product's components & functions can manifest
- Yet these Causes & Effects are rarely fully obvious
  - Pro-active risk mitigation planning must anticipate the unknown and, with little guidance, filter & prioritize virtually infinite failure scenarios
    - That's why we do failure mode effects analyses (FMEA)
  - Even after failure, the causes are sometimes obscure & hidden
    - That's why we do root cause analyses (RCA)

Example of Semantic Concept Retrieval

“Cause Finder” Integrated within a Root Cause Analysis Process





- Extracts ‘cause & effect experience’ from unlimited sources of digital content
- Acts as a virtual subject matter expert delivering cross-domain insights

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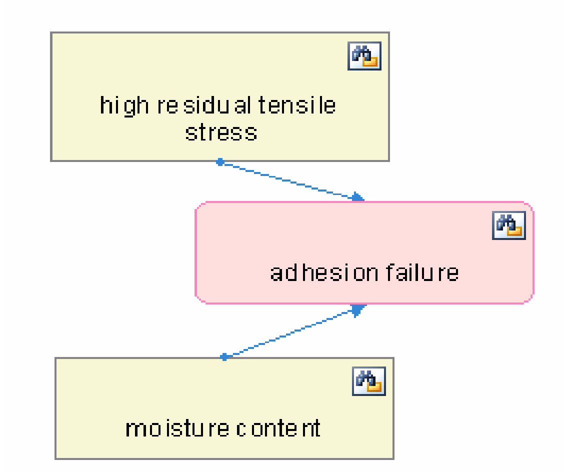
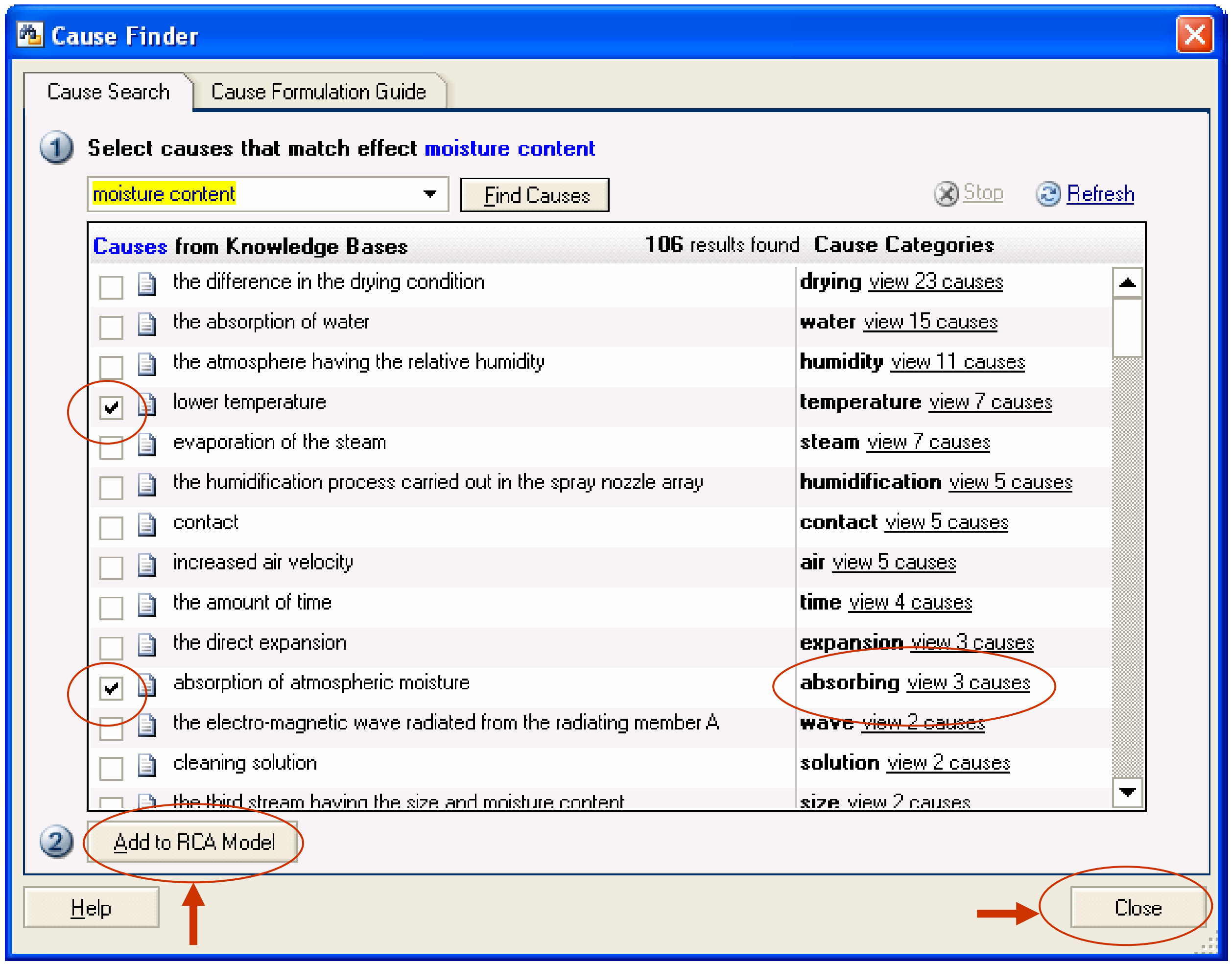
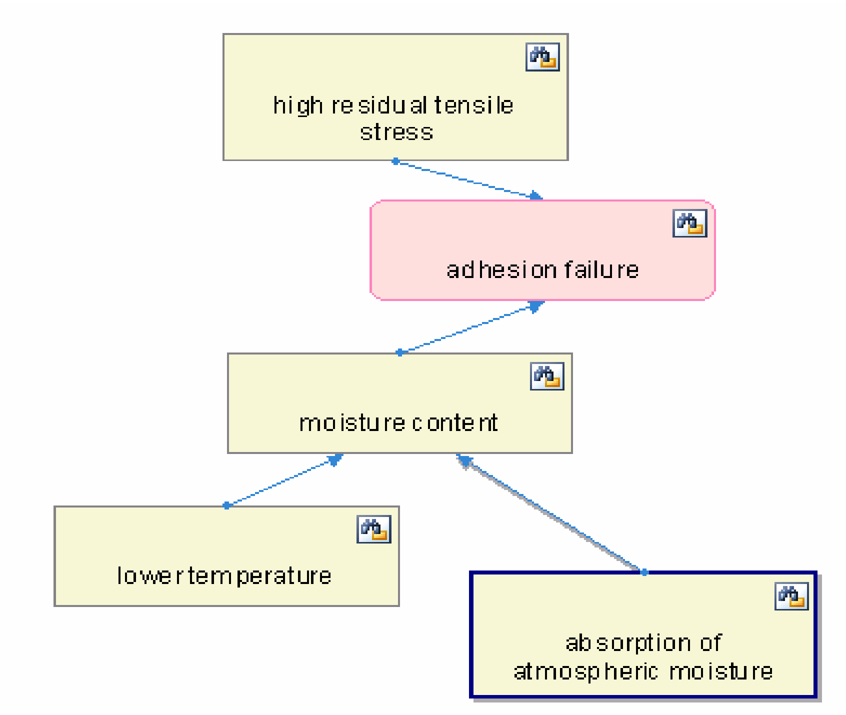




- Review supporting rationale from source documents
- Drill down into the category to see variant instances

Semantic Concept Retrieval

Overcomes Knowledge Myopia & Experience Evaporation



- Automates Build-out of Root Cause & FMEA Models

- Right Place, Right Time Context-specific Answers
- Leverages Corporate Lessons Learned & Tribal Knowledge
- Leverages Expertise from Other Industries & Disciplines
- Reduces Reliance on Critical Subject Matter Experts
- Zero Learning Curve

Goldfire Innovator™
The Innovators' Solution

Software to empower product & process engineers:

- to conceive more and better ideas (ideation)
- by integrating a problem analysis workbench with a patented semantic knowledge engine
- that stimulates creative thinking and extracts concepts from relevant technical content

- Leading provider of software solutions enabling manufacturers to accelerate and systematize product idea generation
- Founded in 1992 - headquartered in Boston, Massachusetts
- Global operations and sales distribution offices in North America, UK, France, Spain, Japan, Korea, China, Taiwan, India, Singapore & Australia
- Over 1,200 customers representing more than 50,000 users worldwide

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THANK YOU !

Q&A ?

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