Ideation Office of Innovation

I-TRIZ Methodology Overview

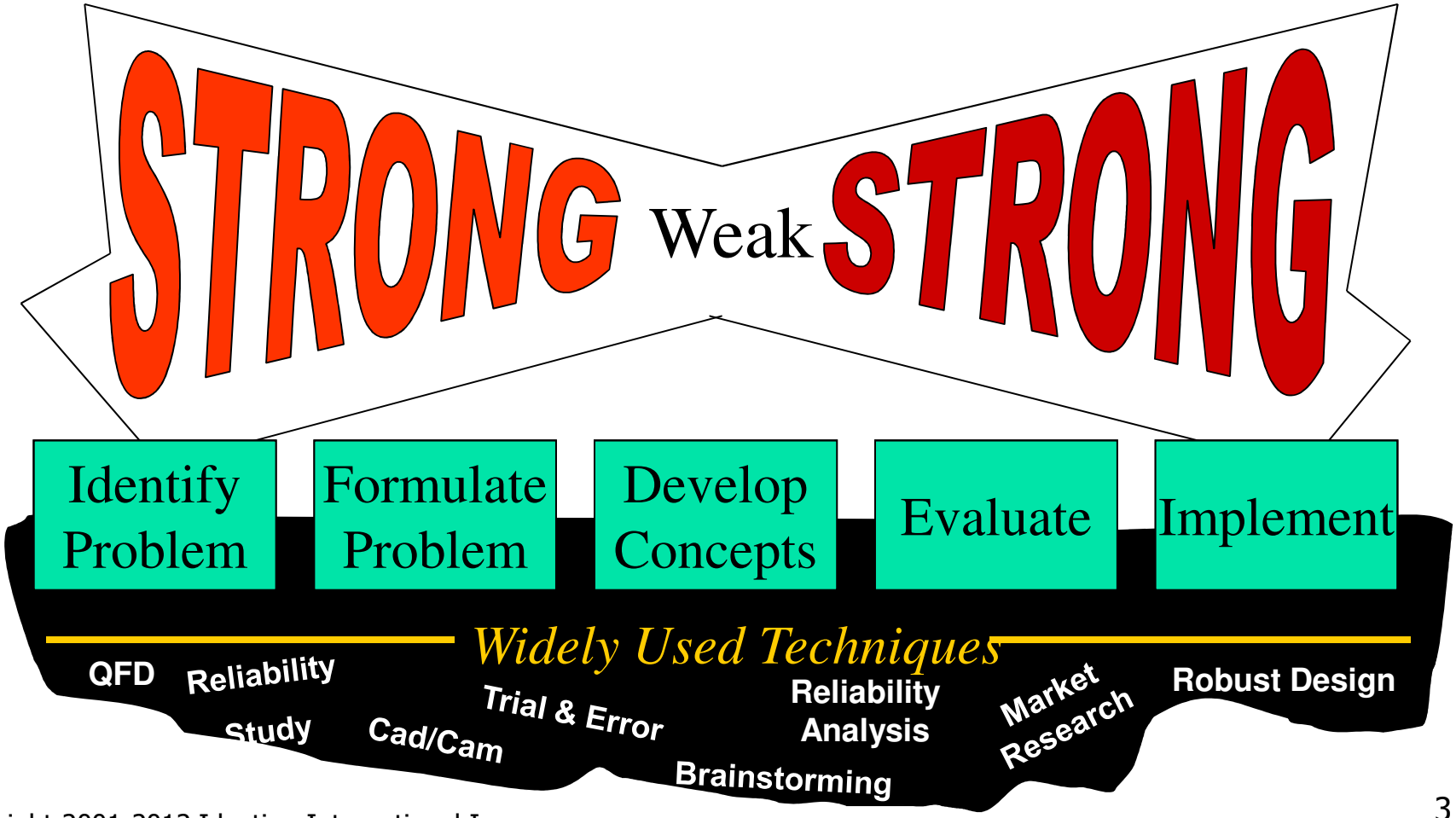
Ideation International
2012

Alla Zusman, TRIZ Master
The Background

- BS and MS in radio physics
- 17 years in corporate research
- 4 years in corporate patent department
- 35 years in TRIZ application, research and development
- Co-founder of the Kishinev TRIZ school (1982, USSR), first TRIZ based commercial engineering company "Progress" (1986, Moldova) and Ideation International (1992, USA)
- Author and co-author of 16 books on TRIZ, US patents and numerous papers; conducted numerous seminars, workshops, and lectures

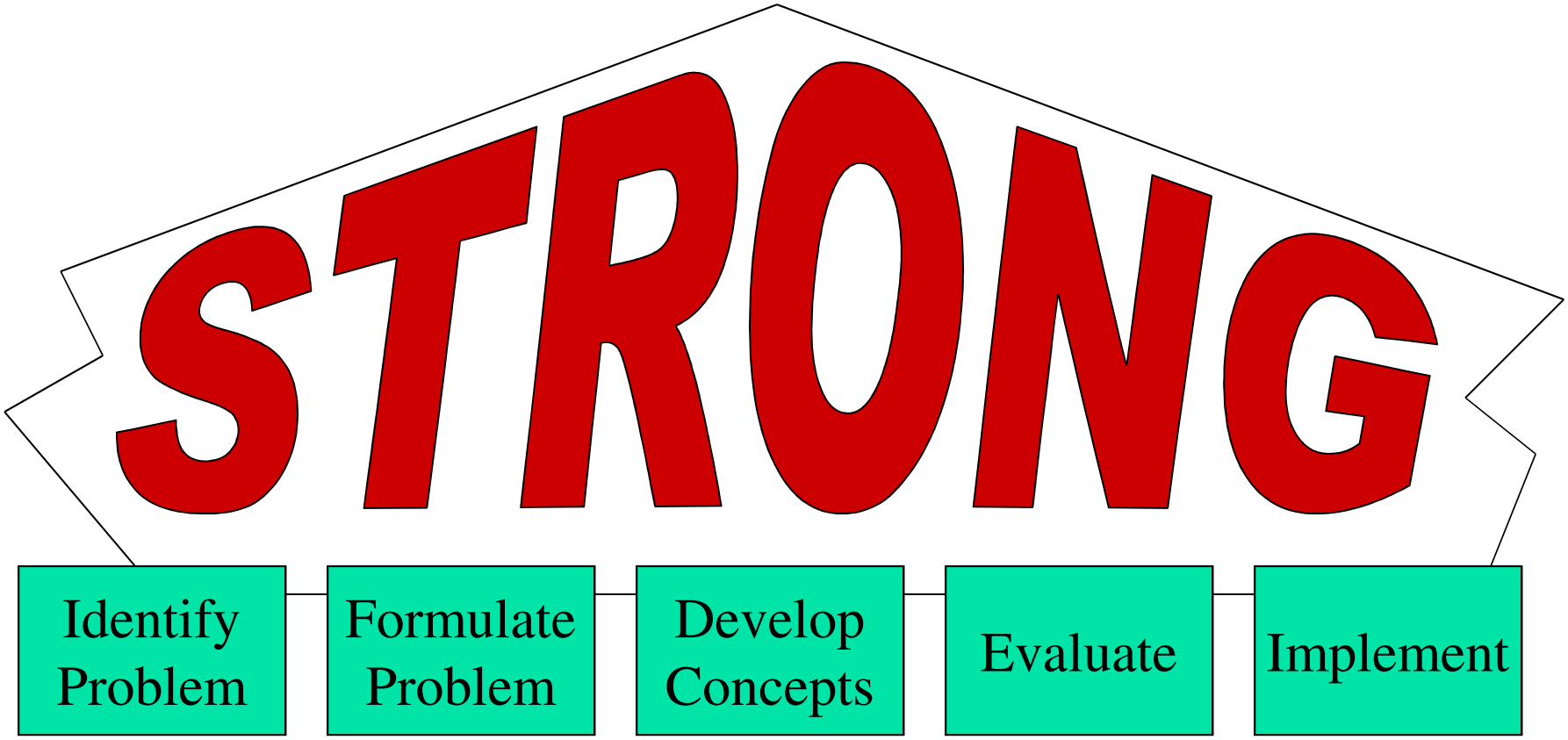
Copyright 2001-2012 Ideation International Inc.

Traditional Innovation Process



Copyright 2001-2012 Ideation International Inc.

The Added Value of Ideation TRIZ



Copyright 2001-2012 Ideation International Inc.

Ideation Office of Innovation

Based on Ideation TRIZ (I-TRIZ) methodology

Inventive Problem Solving (IPS)

A systematic procedure for resolving tough technological problems, enhancing system parameters, improving quality, reducing cost, etc. for current generations of products and technologies.

Anticipatory Failure Determination (AFD)

Failure Analysis

A systematic procedure for identifying the root causes of a failure or other undesired phenomenon in a system, and for making corrections in a timely manner.

Failure Prediction

A systematic procedure for identifying beforehand, and then preventing, all dangerous or harmful events that might be associated with a system.

Directed Evolution® (DE)

A systematic procedure for strategically evolving future generations of technological systems.

Control of Intellectual Property

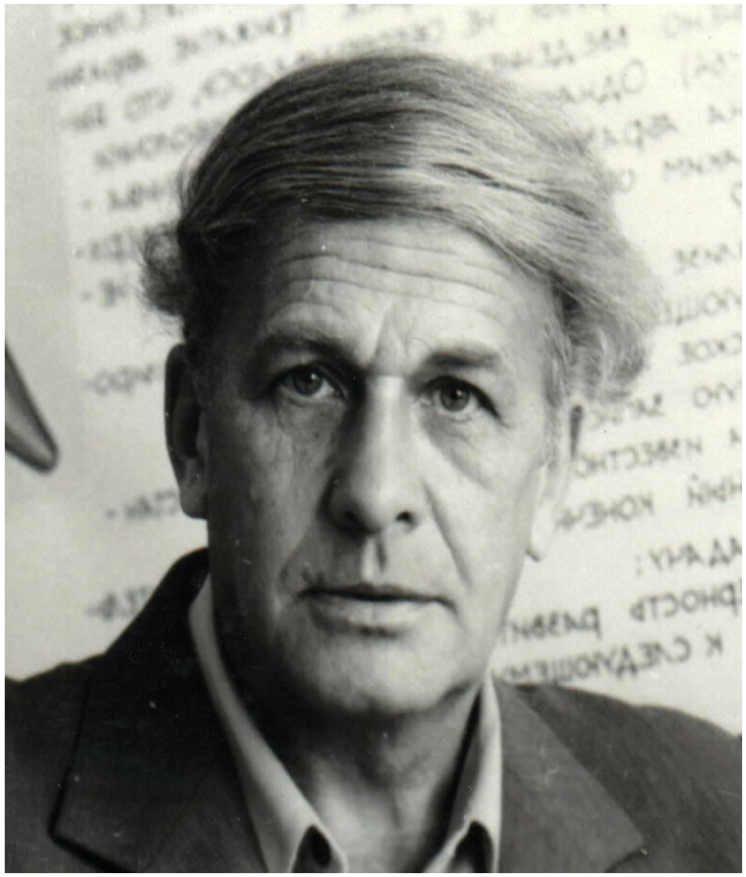
A systematic procedure for increasing IP value and providing protection from infringement and circumvention.

Copyright 2001-2012 Ideation International Inc.

Inventive Problem Solving

TRIZ, the Theory of Inventive Problems Solving

- Russian acronym for the Theory of Inventive Problem Solving originated in 1946 by Genrich Altshuller
- Systematic, structured way of inventing supported with numerous tools
- Science of technological evolution
- Results of analysis of over 2 million worldwide patents within all engineering disciplines



Genrich Altshuller
10/15/26 to 9/24/98

Copyright 2001-2012 Ideation International Inc.

Over 60 Years of Development initiated and led by G. Altshuller and involving hundreds of scientists and inventors

More than 2.000.000 worldwide patents

Practical experience of thousands of scientists, inventors, engineers, managers, businessmen, etc.

Theory of Inventive Problem Solving

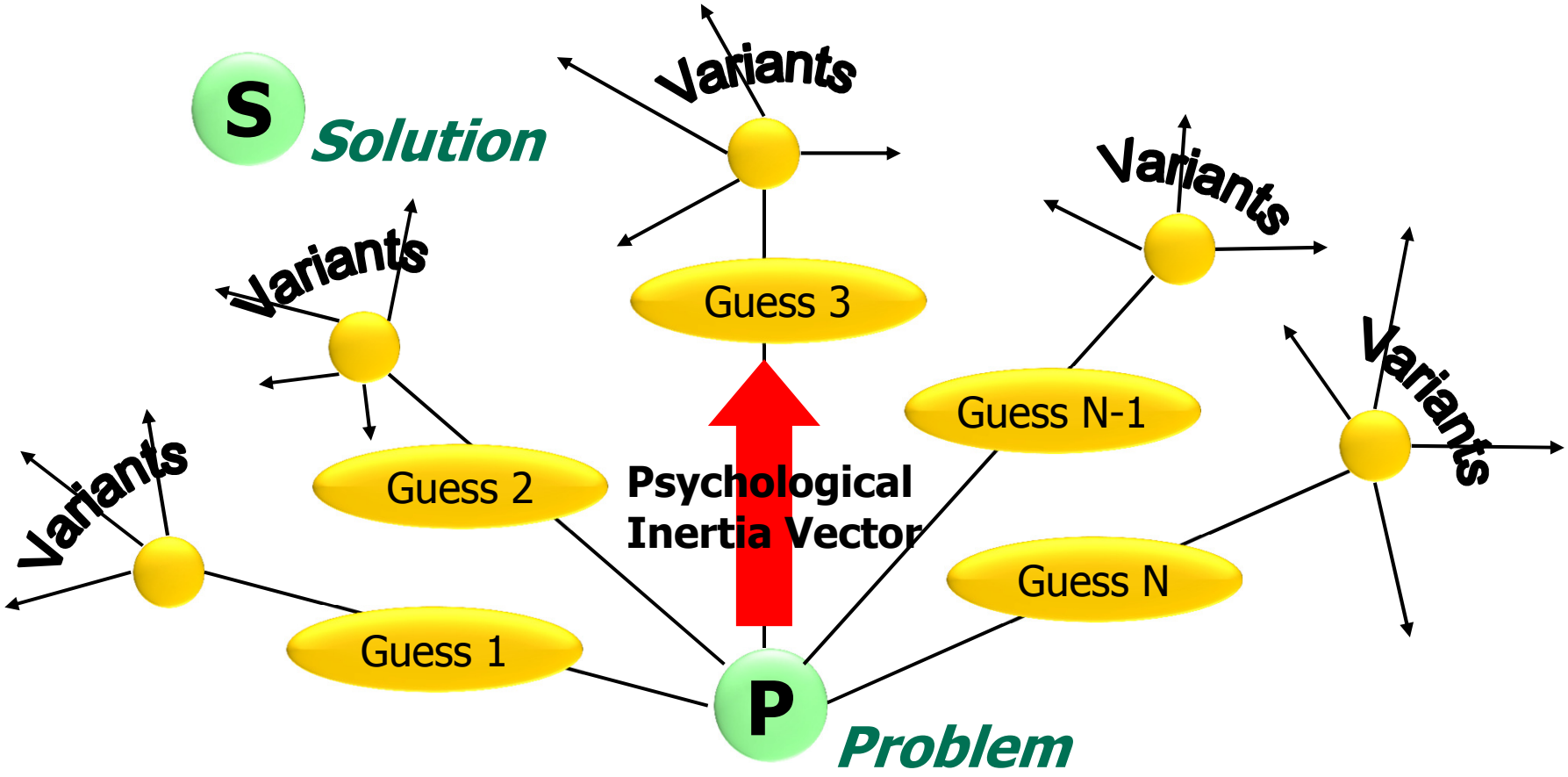
TRIZ

Feedback from solving with TRIZ thousands of problems

History of evolution in different areas of technology and science, social systems, business, management, art, languages, etc.

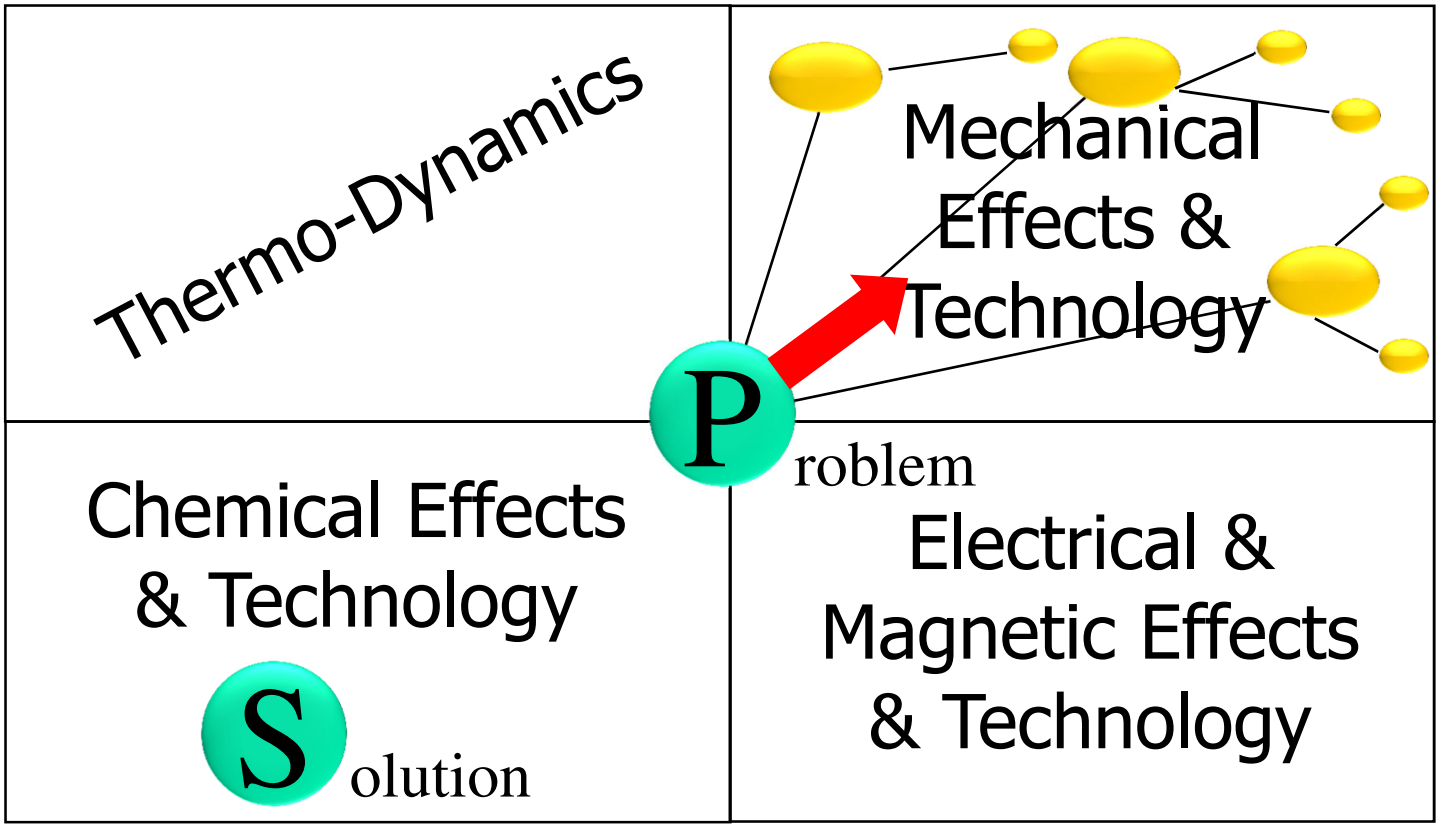
Copyright 2001-2012 Ideation International Inc.

How We Solve Creative Problems Using the Trial & Error Method



Copyright 2001-2012 Ideation International Inc.

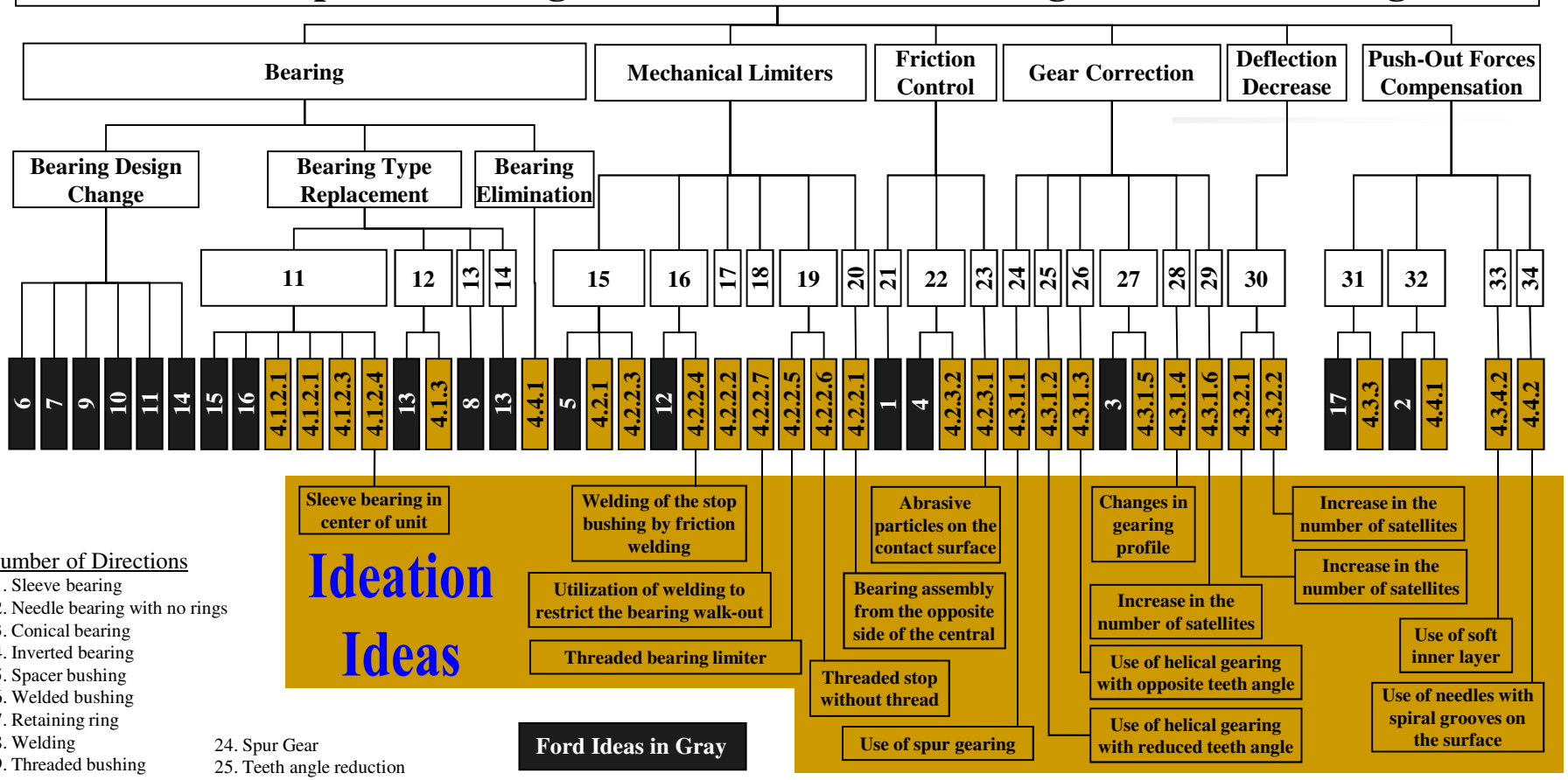
In-Box Thinking and the Solution Space



Copyright 2001-2012 Ideation International Inc.

Ford Motor Company

Road Map -- Technological Problem of the Walking Transaxle Bearing



Number of Directions

11. Sleeve bearing
12. Needle bearing with no rings
13. Conical bearing
14. Inverted bearing
15. Spacer bushing
16. Welded bushing
17. Retaining ring
18. Welding
19. Threaded bushing
20. Step on the bore surface
21. Press fit
22. Loctite
23. Abrasive Particles
24. Spur Gear
25. Teeth angle reduction
26. Gearing angle change
27. Modulus change
28. Satellites Qty change
29. Opposite teeth angle
30. Pre-stress
31. Spline fit change
32. Spiral marks
33. Soft coating of the bearing ring
34. Needles with spiral groove

Ford Ideas in Gray

1. Increase of the compression on the contact surface
2. Spiral marks on the central bore surface
3. Sun gear wall thickness increase (gear correction)
4. Using adhesives (Loctite)
5. Mechanical stop (bushing)
6. Make needle bearing longer
7. Combination of thrust and radial bearing
8. Conical roller bearing
9. Needles profile change (crowned)
10. Bearing ring hardness reduction
11. Bearing ring thickness increase
12. Mechanical stop (welded bushing, small step on the bore surface)
13. Inverted needle bearing (no outer ring)
14. Needles profile change (convex)
15. Sleeve bearing
16. One long bushing per unit
17. Change of the fit of the rear carrier to final drive sun gear spline

Copyright 2001-2012 Ideation International Inc.

Over 100 Techniques exist to enhance the Trial and Error method

Classification of Existing Techniques:

1. Conditioning /Motivating/ Organizing

   Examples: "Napoleon technique," listening to music, use of cards

2. Randomizing

   Example: Brainstorming

3. Focusing

   Example: Attribute listing

4. Systems

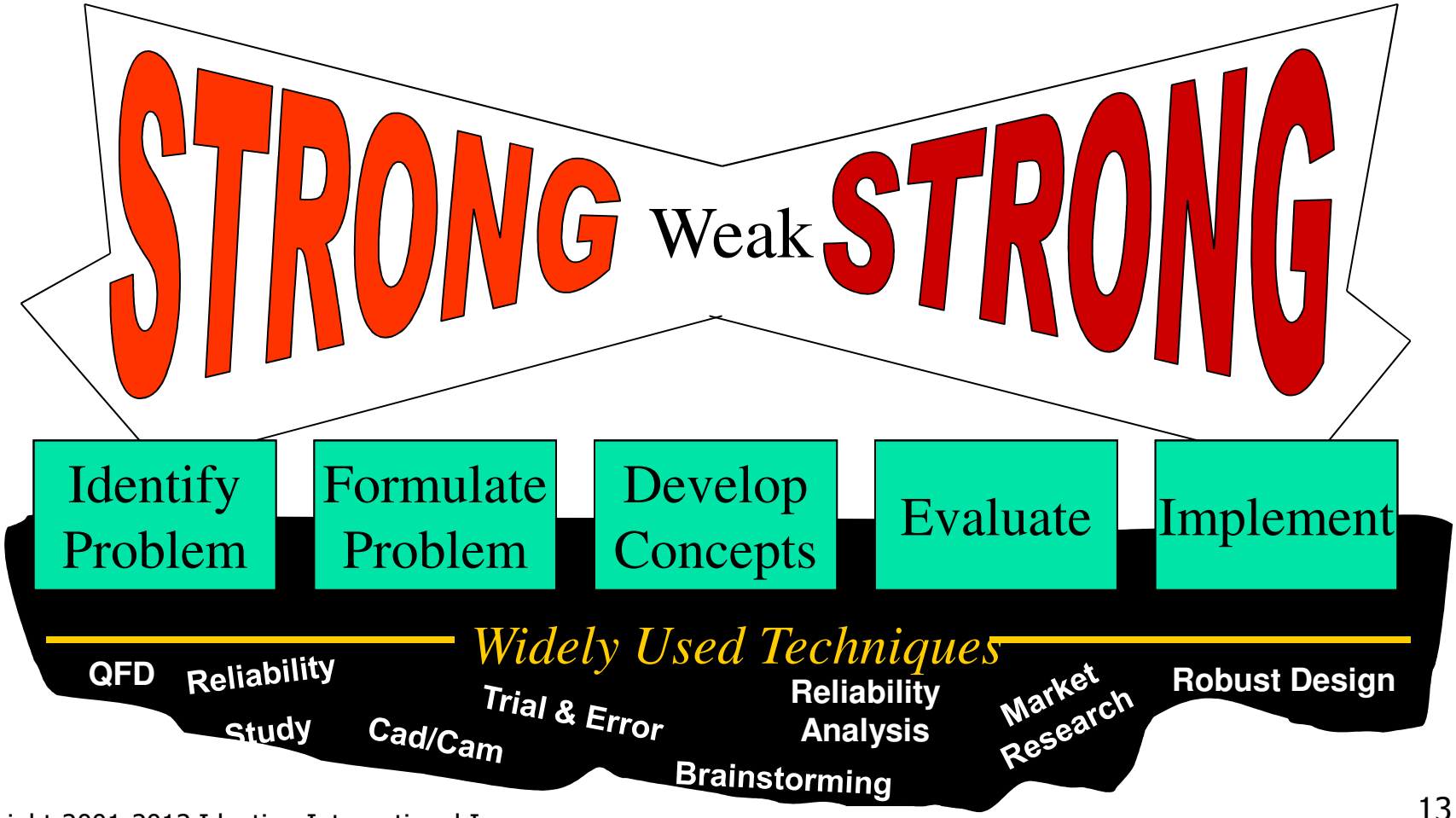
   Example: QFD

5. Pointing

   Examples: Problem reversal (inversion)

Copyright 2001-2012 Ideation International Inc.

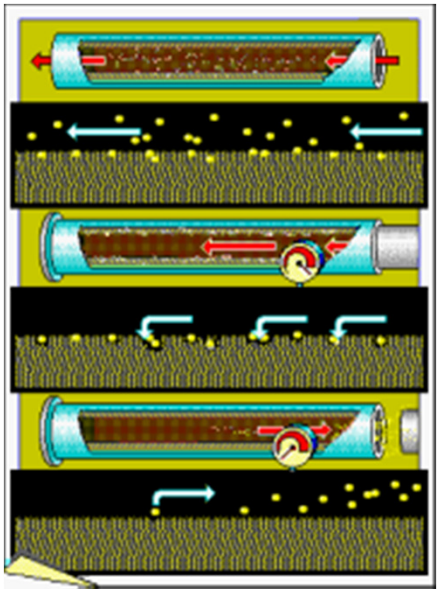
Traditional Innovation Process

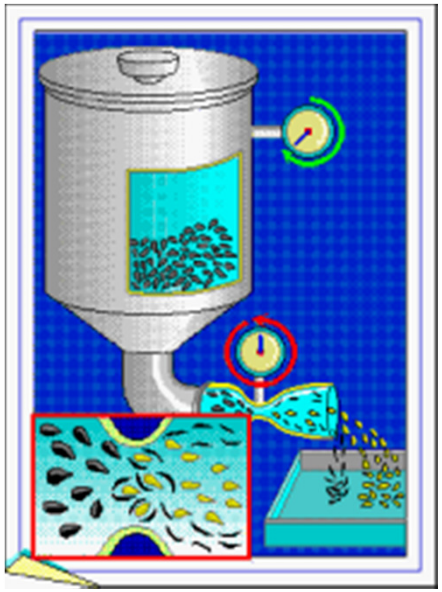


Copyright 2001-2012 Ideation International Inc.

Patterns of Inventions

The same fundamental solutions for different problems were used over and over again





I-TRIZ Operator: Slowly increase then abruptly drop pressure

Over 400 Operators have been extracted from over 2 million of patents

Copyright 2001-2012 Ideation International Inc.

Patterns of Evolution: The Primary TRIZ Postulate

- Systems evolve not randomly, but according to objective patterns
- Patterns can be identified based on the analysis of historical development of technology, markets and social trends
- Identified patterns can be purposefully used for system development, avoiding numerous blind trials

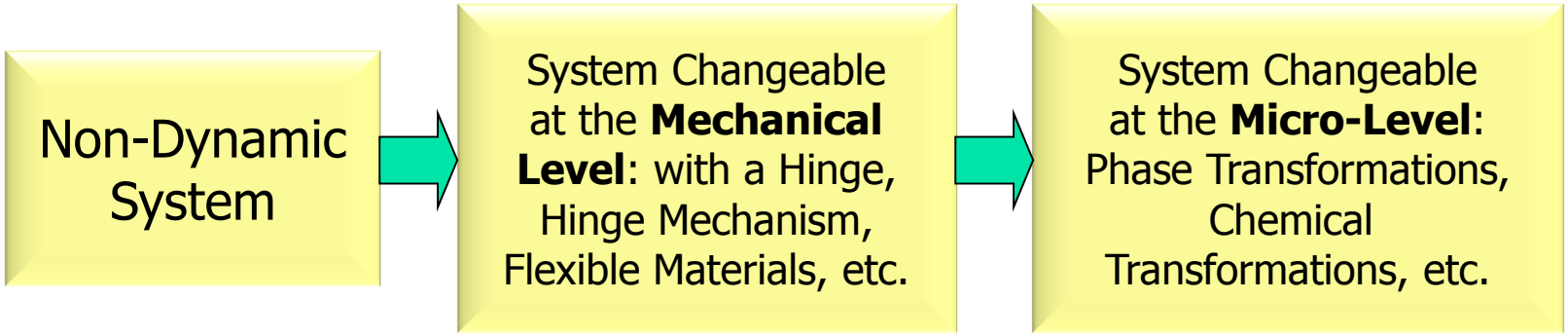
Patterns of Evolution: Common threads between evolving systems.

Copyright 2001-2012 Ideation International Inc.

Evolution Toward Increased Dynamism

- Increasing system dynamism allows functions to be performed with greater flexibility or diversity

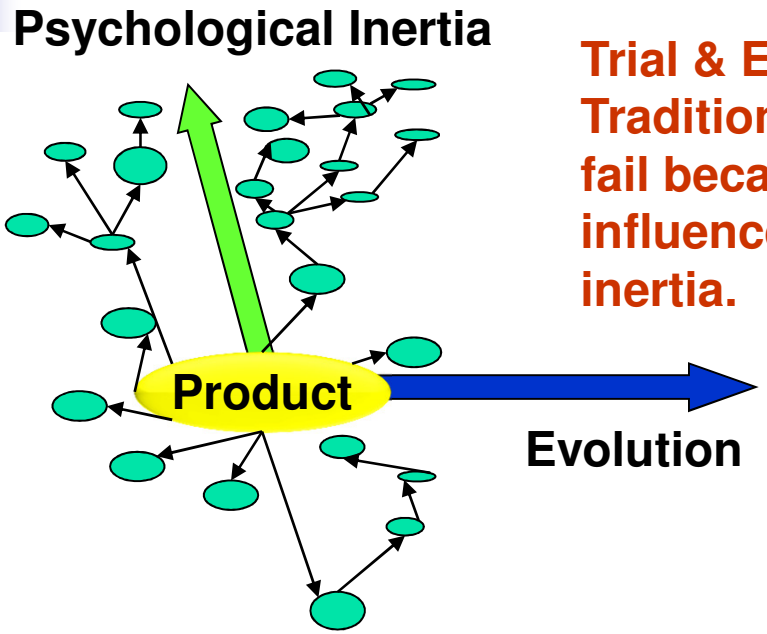
- Line of evolution: Increasing degree of freedom



- Over 500 lines have been identified for technology, business, marketing, etc.

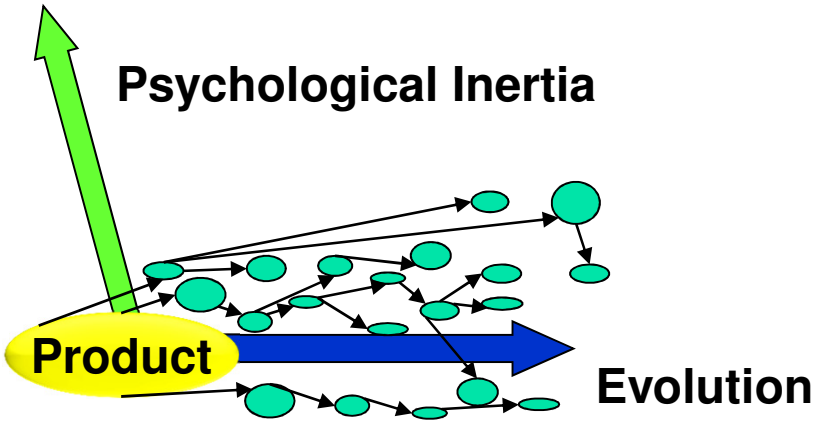
Copyright 2001-2012 Ideation International Inc.

Evolutionary Approach versus Traditional Trial & Error Method



Trial & Error:
Traditionally, majority of trials fail because they are influenced by psychological inertia.

Evolutionary Approach:
Majority of trials are productive because they follow defined Patterns of Evolution.



Copyright 2001-2012 Ideation International Inc.

TRIZ Differentiation

- TRIZ is the only innovation methodology that is:
  - Innovation knowledge based – System of Operators
    - Collected
    - Refined
    - Structured
    - Ready to use
  - Evolutionary directed
    - Narrowing down solution space by following patterns of evolution
    - Searching for solutions in right directions and places
- I-TRIZ also incorporates all other techniques utilized in appropriate processes and tools

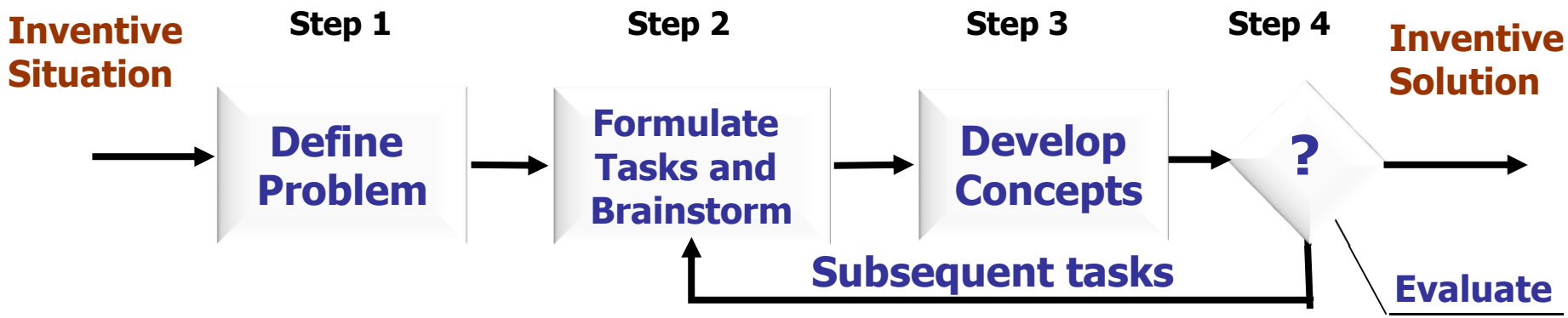
Copyright 2001-2012 Ideation International Inc.

Structured Process for Inventive Problem Solving (Software supported)

STEP	NAME/PURPOSE	ACTIONS
1	**Document the problem**	**Preliminary problem analysis using the Innovation Situation Questionnaire (ISQ)**
2	**Problem formulation and brainstorming**	**Model the problem situation; generate an exhaustive set of Directions for Innovation; work with Operators**
3	**Develop concepts**	**Integrate ideas, develop solution concepts**
4	**Evaluate results and plan implementation**	**Compare solution concepts, further improve selected concept(s); reveal and prevent failures**

Copyright 2001-2012 Ideation International Inc.

Ideation Process and Tools for Inventive Problem Solving (IPS)



ISQ®

I-TRIZ Differentiation:
A unified and integrated process by which all types of problems can be treated in the same way

uation

Copyright 2001-2012 Ideation International Inc.

Software to Support Inventive Problem Solving Process

Process steps	**IPS Software**		
	IBS Simplified version	**IWB® Professional tool**	**KW® Professional tool**
Problem definition	System Approach	ISQ®	ISQ®
Problem formulation	Function modeling	PF®	PF®
Idea generation and concept development	Limited set of Operators **for technical problems**	Complete System of Operators **for technical problems**	Set of Operators for **non-technical problems**
Evaluation of results	Formulating subsequent tasks	Concepts evaluation and enhancement	Concepts evaluation and enhancement

Copyright 2001-2012 Ideation International Inc.

Innovation WorkBench® Software Demo

Ideation Office of Innovation

Based on Ideation TRIZ (I-TRIZ) methodology

Inventive Problem Solving (IPS)

A systematic procedure for resolving tough technological problems, enhancing system parameters, improving quality, reducing cost, etc. for current generations of products and technologies.

Anticipatory Failure Determination (AFD)

Failure Analysis

A systematic procedure for identifying the root causes of a failure or other undesired phenomenon in a system, and for making corrections in a timely manner.

Failure Prediction

A systematic procedure for identifying beforehand, and then preventing, all dangerous or harmful events that might be associated with a system.

Directed Evolution® (DE)

A systematic procedure for strategically evolving future generations of technological systems.

Control of Intellectual Property

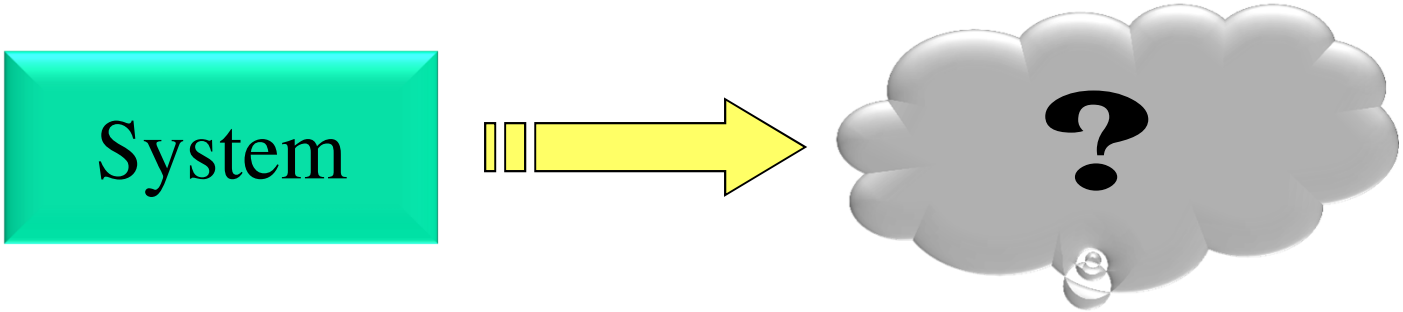
A systematic procedure for increasing IP value and providing protection from infringement and circumvention.

Copyright 2001-2012 Ideation International Inc.

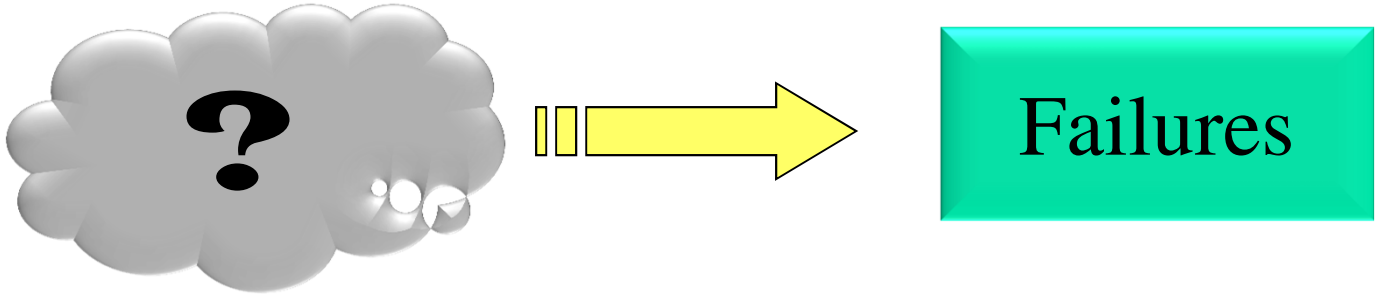
Anticipatory Failure Determination

Anticipatory Failure Determination

- What failures may occur?



- Why failures did occur?



Copyright 2001-2012 Ideation International Inc.

Anticipatory Failure Determination

- Replace “what” and “why” with “how to”
- Try to solve this new problem using problem solving tools
- Consider each solution idea to be a possible hypothesis
- Test the hypothesis
  - Does the system have resources to make possible failures real?
- Repeat for every hypothesis

Copyright 2001-2012 Ideation International Inc.

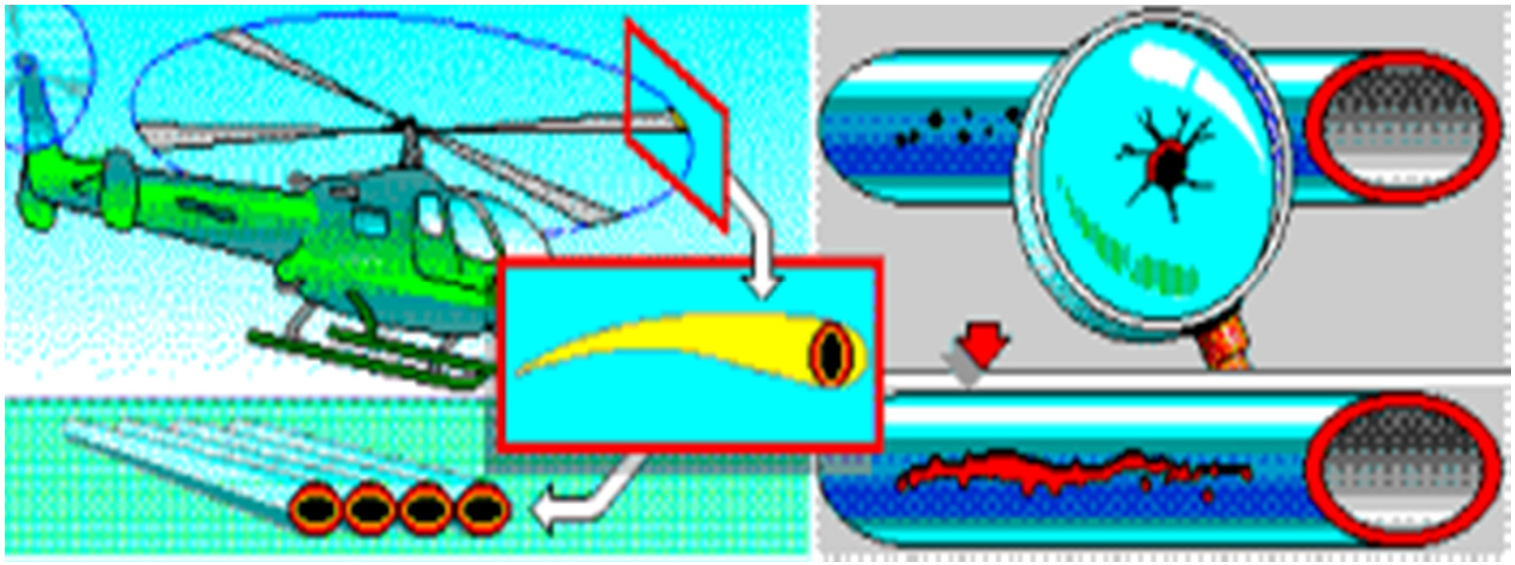
Structured Process for Anticipatory Failure Determination AFD® (Software Supported)

STEP	NAME/PURPOSE	ACTION
1	Document the problem	Complete and analyze AFD Ideation Process Questionnaire
2	Formulate the problem	Formulate inverted problem
3	Develop hypotheses	Develop an exhaustive set of potential failure scenarios utilizing general technological and specific AFD knowledge base tools
4	Verification	Verifying potential scenarios and selecting problems for solving
5	Eliminate failures	Solving problems (see IPS)

Copyright 2001-2012 Ideation International Inc.

Failure Analysis:
Why did “black dots” appear?

A problem of 30 years…



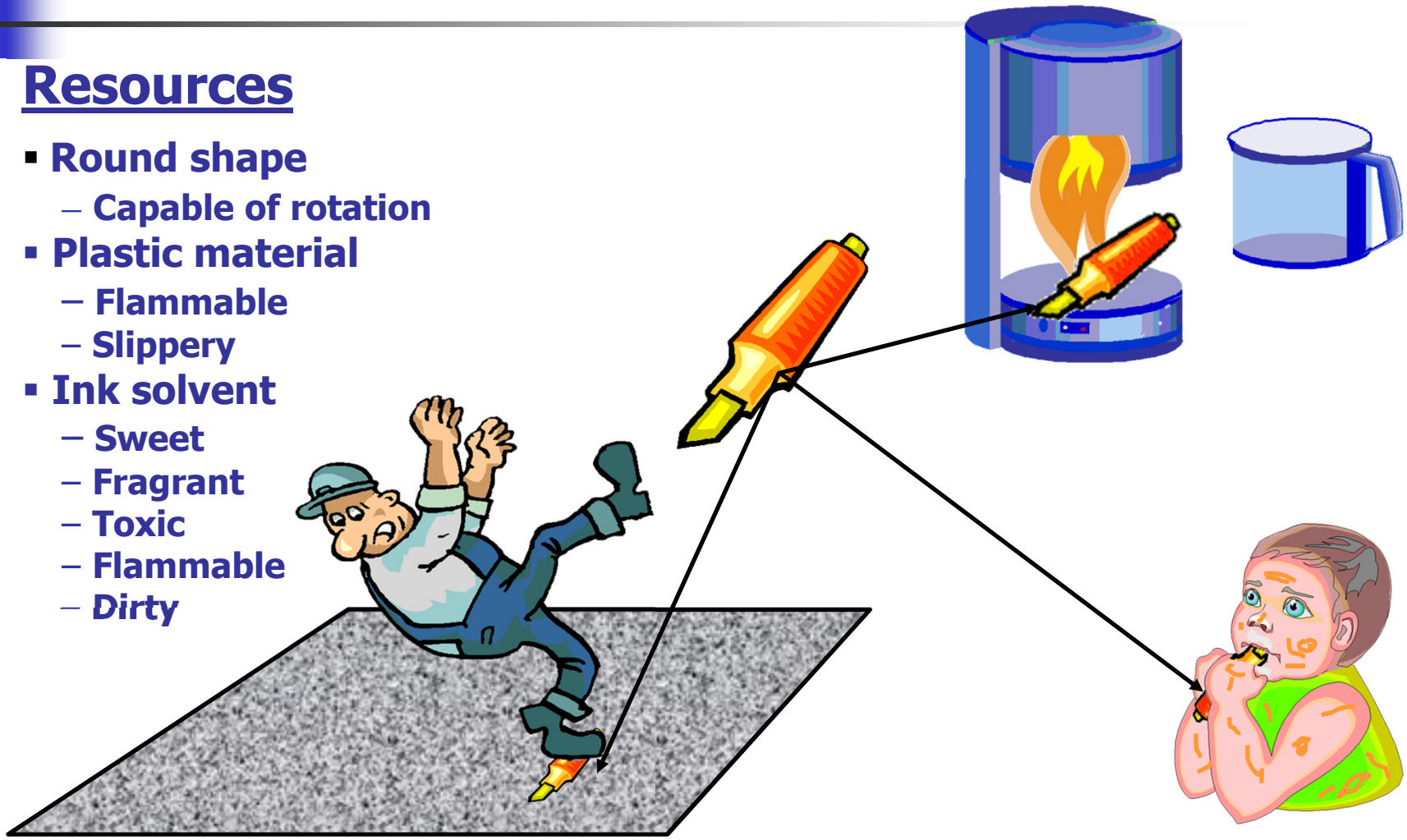
Copyright 2001-2012 Ideation International Inc.

Ideation Failure Prediction:

How to make a marker dangerous?

Resources

- **Round shape**
  - **Capable of rotation**
- **Plastic material**
  - **Flammable**
  - **Slippery**
- **Ink solvent**
  - **Sweet**
  - **Fragrant**
  - **Toxic**
  - **Flammable**
  - ***Dirty***

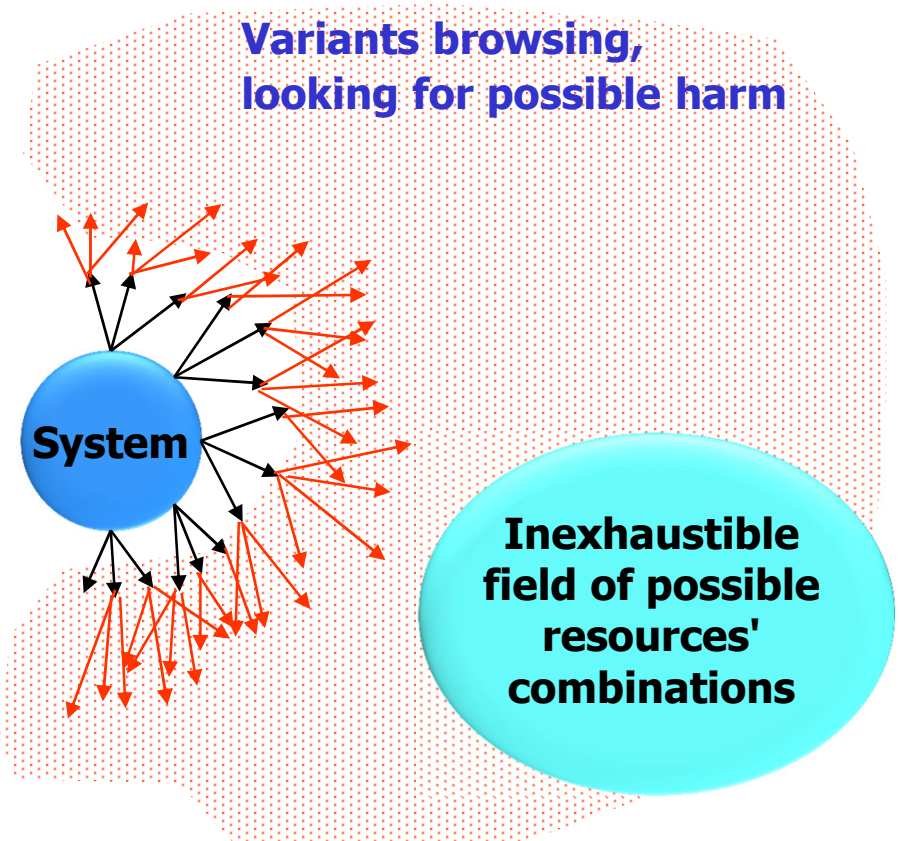


Copyright 2001-2012 Ideation International Inc.

Comparison of Different Methods for Failure Prediction

Direct approach (FMEA, HAZOP. etc.)

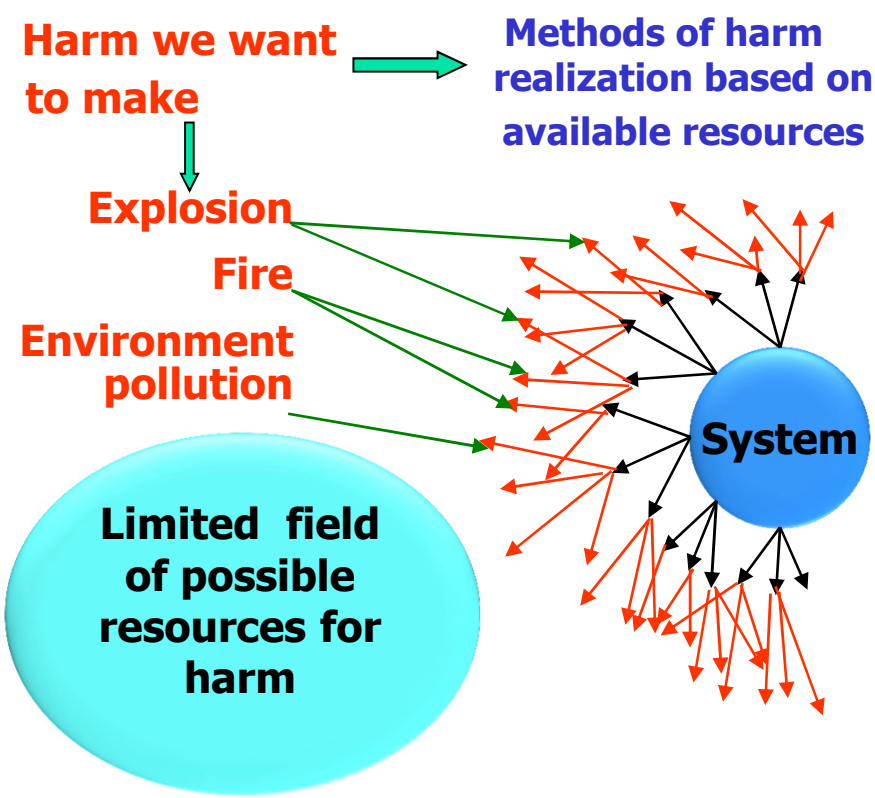
What harm can happen?



→ **Operations or sub-systems**

Inverted approach (Ideation Failure Prediction)

What harm can we make?



→ **Parameters (as resources)**

Copyright 2001-2012 Ideation International Inc.

Ideation Office of Innovation

Based on Ideation TRIZ (I-TRIZ) methodology

Inventive Problem Solving (IPS)

A systematic procedure for resolving tough technological problems, enhancing system parameters, improving quality, reducing cost, etc. for current generations of products and technologies.

Anticipatory Failure Determination (AFD)

Failure Analysis

A systematic procedure for identifying the root causes of a failure or other undesired phenomenon in a system, and for making corrections in a timely manner.

Failure Prediction

A systematic procedure for identifying beforehand, and then preventing, all dangerous or harmful events that might be associated with a system.

Directed Evolution® (DE)

A systematic procedure for strategically evolving future generations of technological systems.

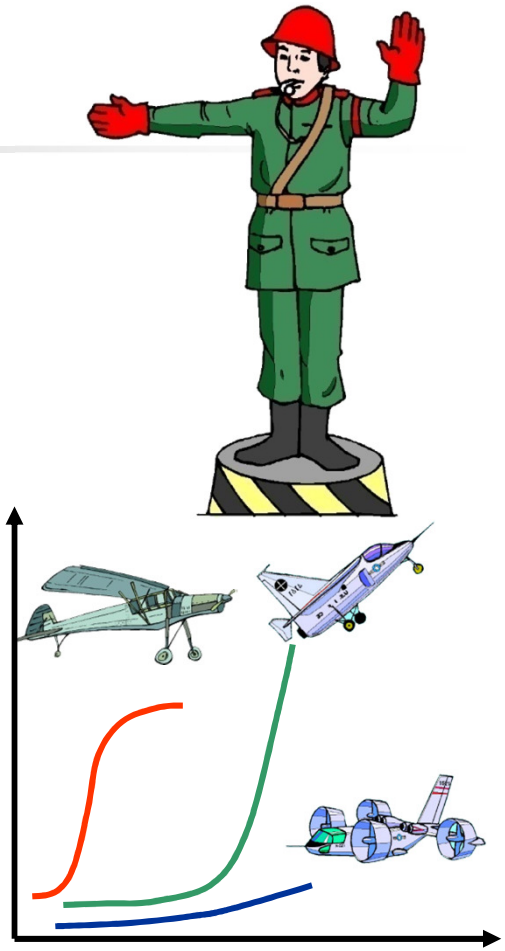
Control of Intellectual Property

A systematic procedure for increasing IP value and providing protection from infringement and circumvention.

Copyright 2001-2012 Ideation International Inc.

Directed Evolution®

- A systematic process to predict the future generations of a system by inventing them, and
- A systematic approach targeting the identification of a comprehensive set of potential evolutionary scenarios for:
  - Products/Services/Processes
  - Technologies
  - Organizational structures
  - Industries
  - Markets



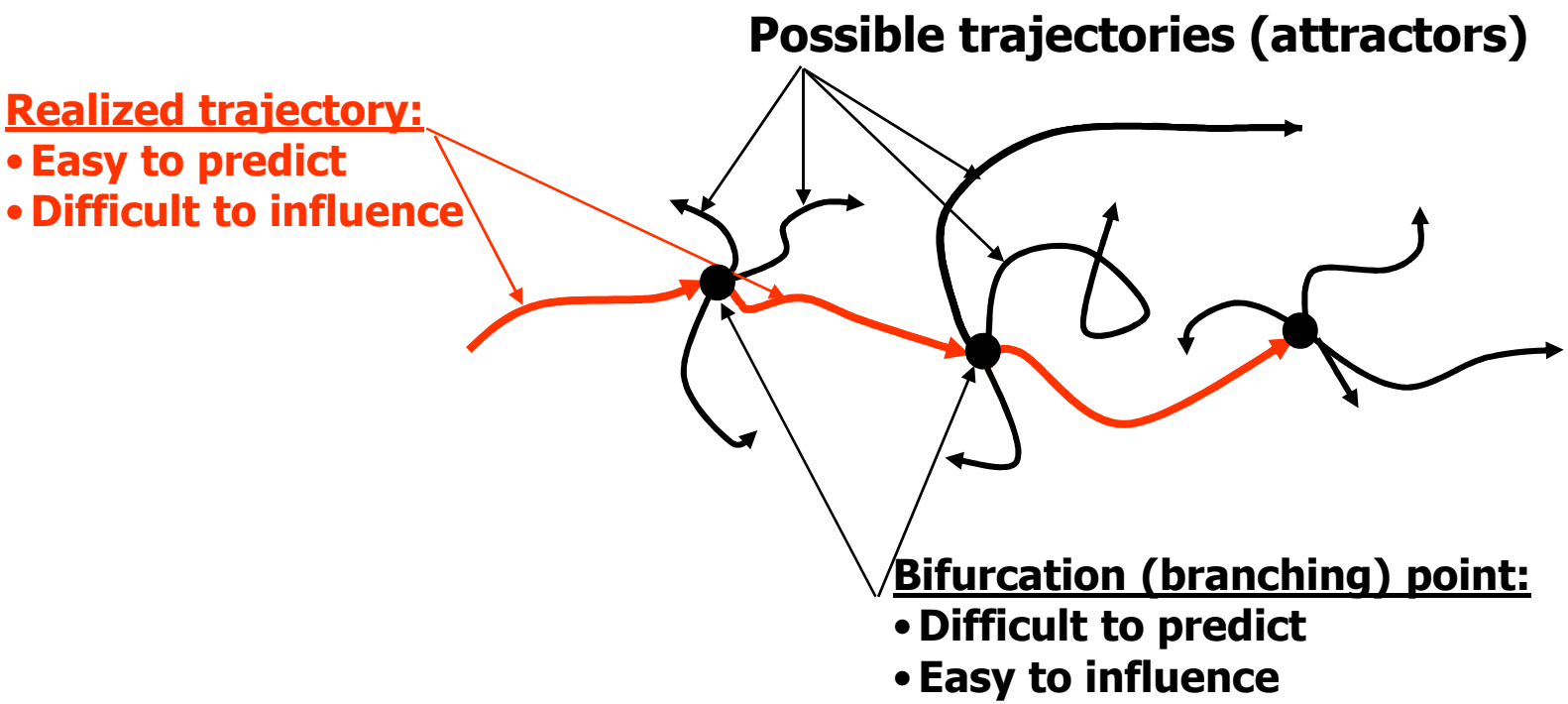
Copyright 2001-2012 Ideation International Inc.

The History

- Technological Forecasting (1950's)
  - Utilizes probabilistic modeling of future characteristics of various systems
- TRIZ Forecasting (1970's)
  - Utilizes selected TRIZ-based tools to generate an idea(s) helpful for the next product or process generation
- Directed Evolution (1990's)
  - Utilizes extended set of Patterns/Lines of Evolution to generate an exhaustive set of potential scenarios of system evolution

Copyright 2001-2012 Ideation International Inc.

How is it Possible?



Copyright 2001-2012 Ideation International Inc.

Based on Patterns of Evolution

- Systems evolve not randomly, but according to objective patterns
- Patterns can be identified based on the analysis of historical development of technology, markets and social trends
- Identified patterns can be purposefully used for system development, avoiding numerous blind trials

Copyright 2001-2012 Ideation International Inc.

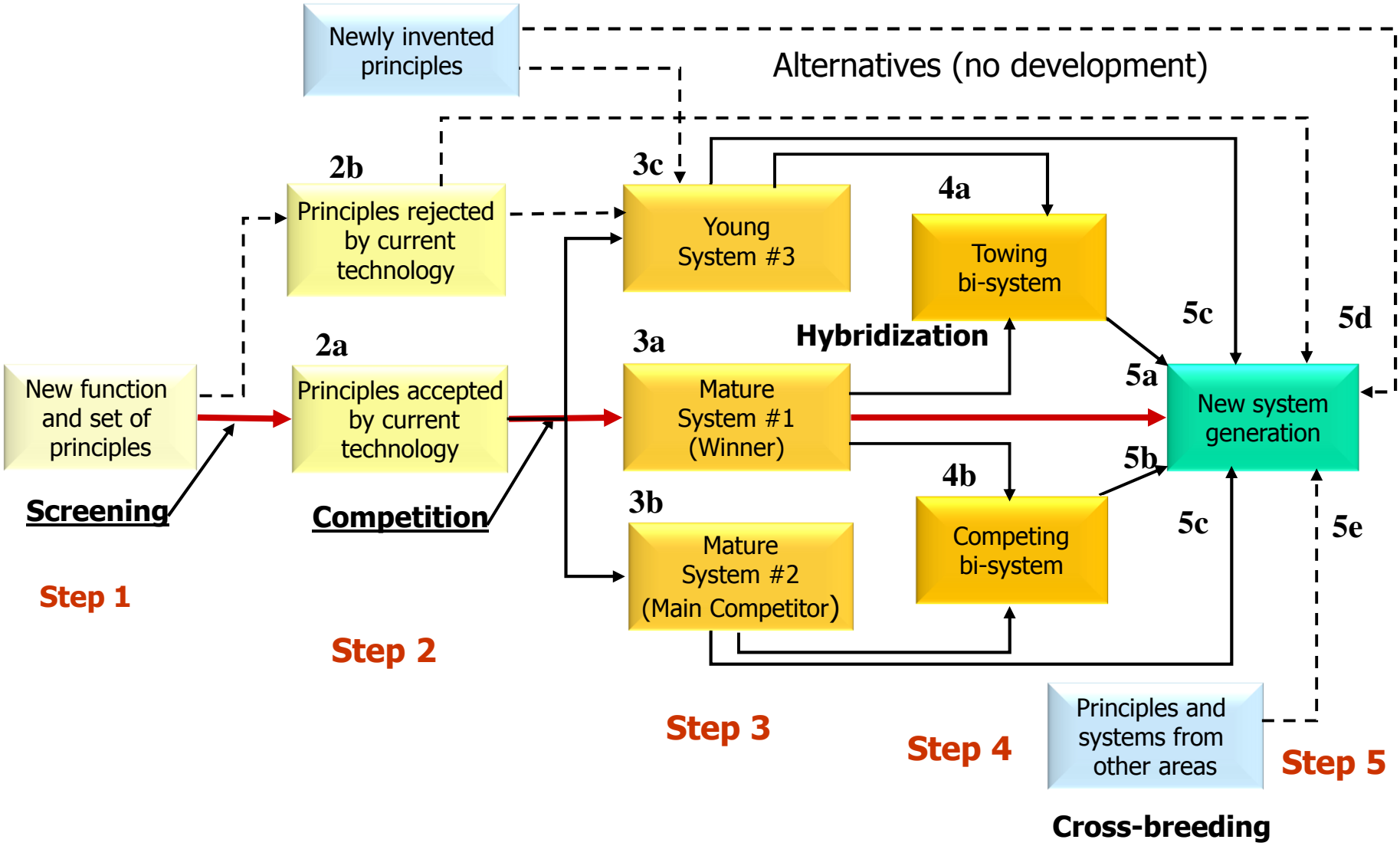
Patterns of Evolution

Patterns of Evolution: Common threads between evolving systems.

1. Stages of Evolution
2. Evolution toward Increased Ideality
3. Non-Uniform Development of System Elements
4. Evolution toward Increased Dynamism and Controllability
5. Increased Complexity Then Simplification
6. Evolution with Matching and Mismatching Elements
7. Evolution toward Micro-level and Increased Use of Fields
8. Evolution toward Decreased Human Involvement

Copyright 2001-2012 Ideation International Inc.

General Scenario of System Evolution



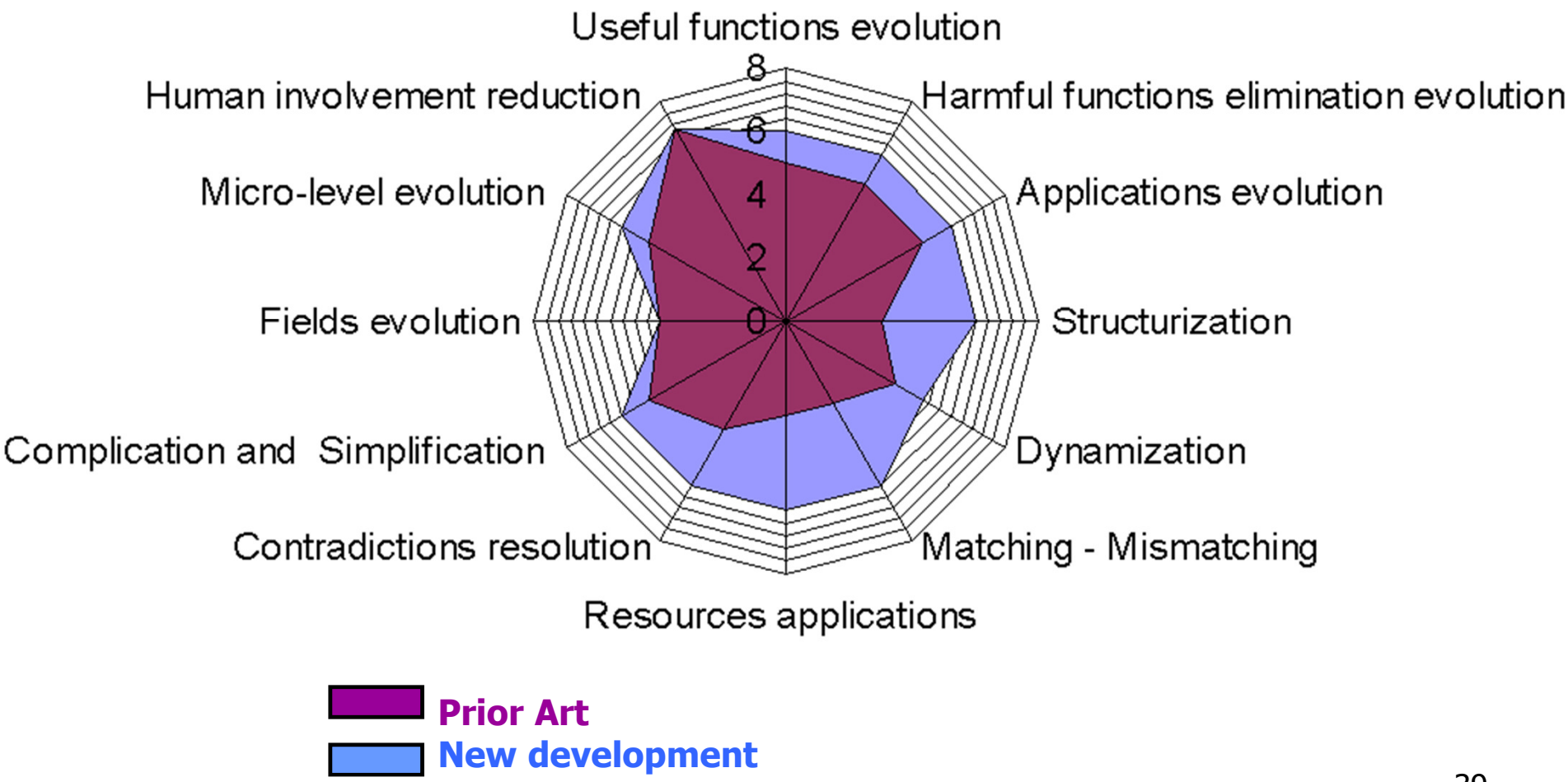
Copyright 2001-2012 Ideation International Inc.

Structured Process for Directed Evolution® (Software Supported)

STEP	ACTION	CONTENTS
1	Analyze and evaluate the system's evolution to-date	▪ Complete the Innovation Process Questionnaire ▪ Work with the problem formulation of multiple paradigms ▪ Work with failure analysis & prediction ▪ Collect information about the system's evolution and related markets ▪ Collect information about inherited ideas ▪ Identify relevant Patterns and Lines of Evolution, and map the system
2	Develop potential scenarios of future evolution	▪ Identify and document missing and future evolutionary steps (technology and market) ▪ Develop a bank of evolutionary resources and limitations ▪ Identify relevant problems to be overcome and their overall scope ▪ Solve selected problems ▪ Integrate evolutionary steps with market readiness
3	Decision making	▪ Selection of scenarios for implementation ▪ Work with failure prediction
4	Secure intellectual capital	▪ Build a patent fence or entertain other protection options
5	Implement an action plan	▪ Develop an implementation plan for the development of the next generation of the product(s)

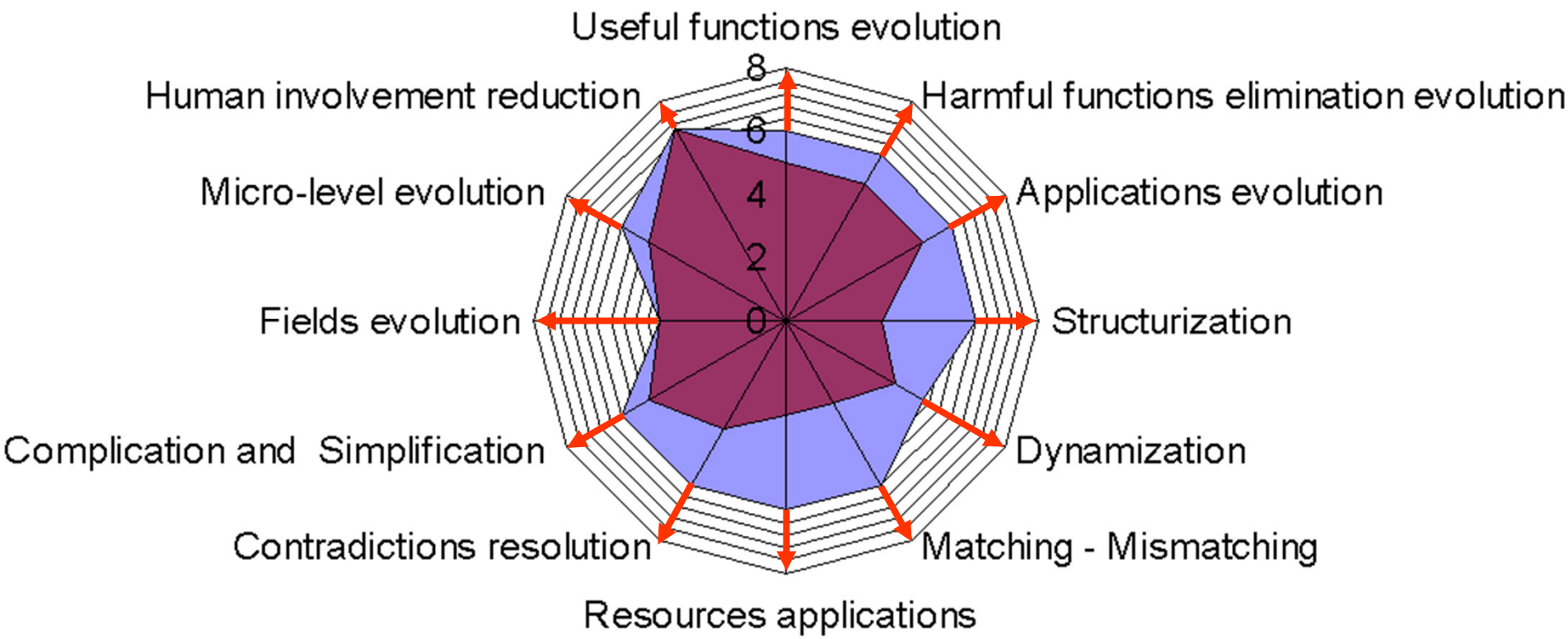
Copyright 2001-2012 Ideation International Inc.

Assessment of Evolutionary Potential



Copyright 2001-2012 Ideation International Inc.

Assessment of Evolutionary Potential



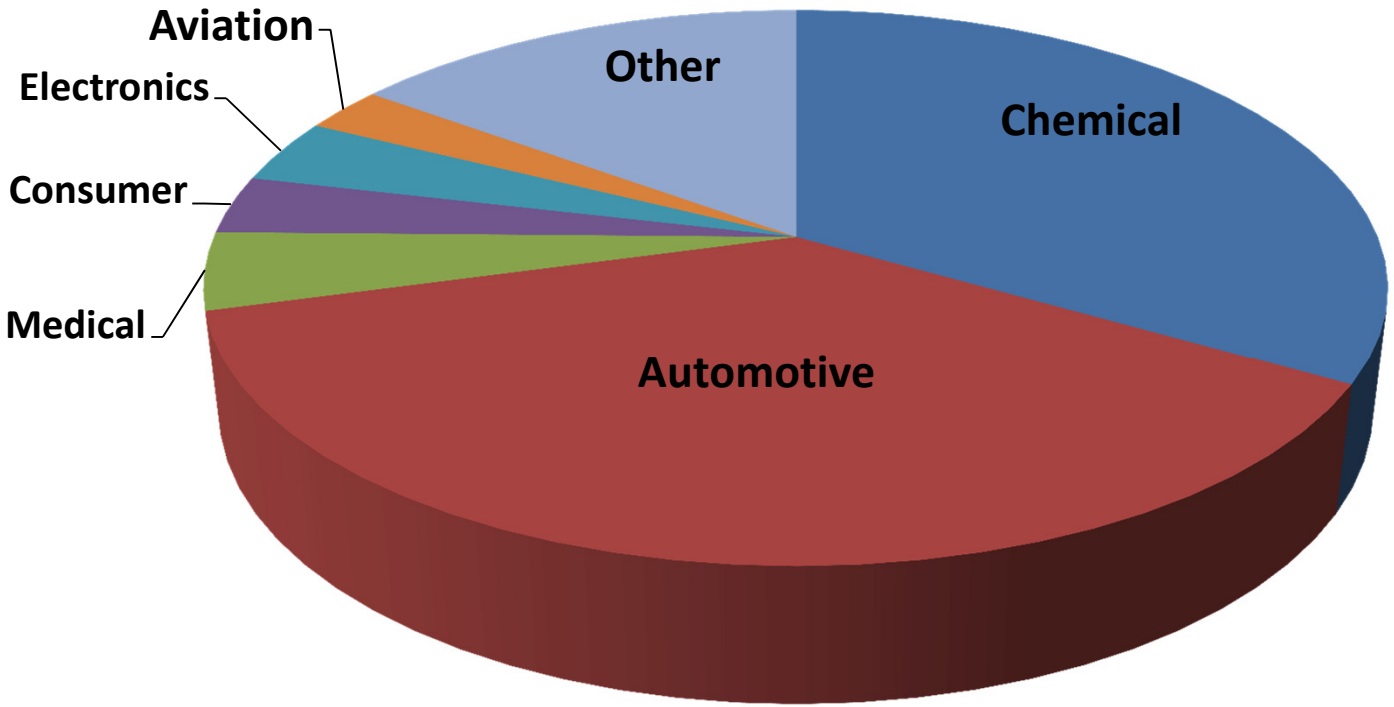
Prior Art

New development

Next evolution steps →

Copyright 2001-2012 Ideation International Inc.

Projects Completed by Ideation



Copyright 2001-2012 Ideation International Inc.

Practical Application: Strategically Evolved Technological Systems

EXAMPLES

- Chemical Industry
  - New Generation of Existing Chemical Processing Plant
  - Processing of New Chemical
- Heavy Equipment
  - Lifting Cranes
- Automotive Industry
  - Parking Brakes
  - Doors
  - Cable Applications
- Medical Industry
  - Surgical Instrumentation
- Oil Industry
  - Control of Oil Production
- Materials Development
  - Super Absorbent Fibers
  - Plastics
  - Packaging
- Fluid Systems
  - Water Pumps
  - Hazardous Materials Pumps
- Commercial Products
  - Sanitary Products
  - Foot Massagers
  - Electric Shavers
  - Hair Care Products
    - Combs, Hair Dryers, Curling Irons, Hair Clippers
- Stock / Commodity Exchange

Copyright 2001-2012 Ideation International Inc.

Ideation Office of Innovation

Based on Ideation TRIZ (I-TRIZ) methodology

Inventive Problem Solving (IPS)

A systematic procedure for resolving tough technological problems, enhancing system parameters, improving quality, reducing cost, etc. for current generations of products and technologies.

Anticipatory Failure Determination (AFD)

Failure Analysis

A systematic procedure for identifying the root causes of a failure or other undesired phenomenon in a system, and for making corrections in a timely manner.

Failure Prediction

A systematic procedure for identifying beforehand, and then preventing, all dangerous or harmful events that might be associated with a system.

Directed Evolution® (DE)

A systematic procedure for strategically evolving future generations of technological systems.

Control of Intellectual Property

A systematic procedure for increasing IP value and providing protection from infringement and circumvention.

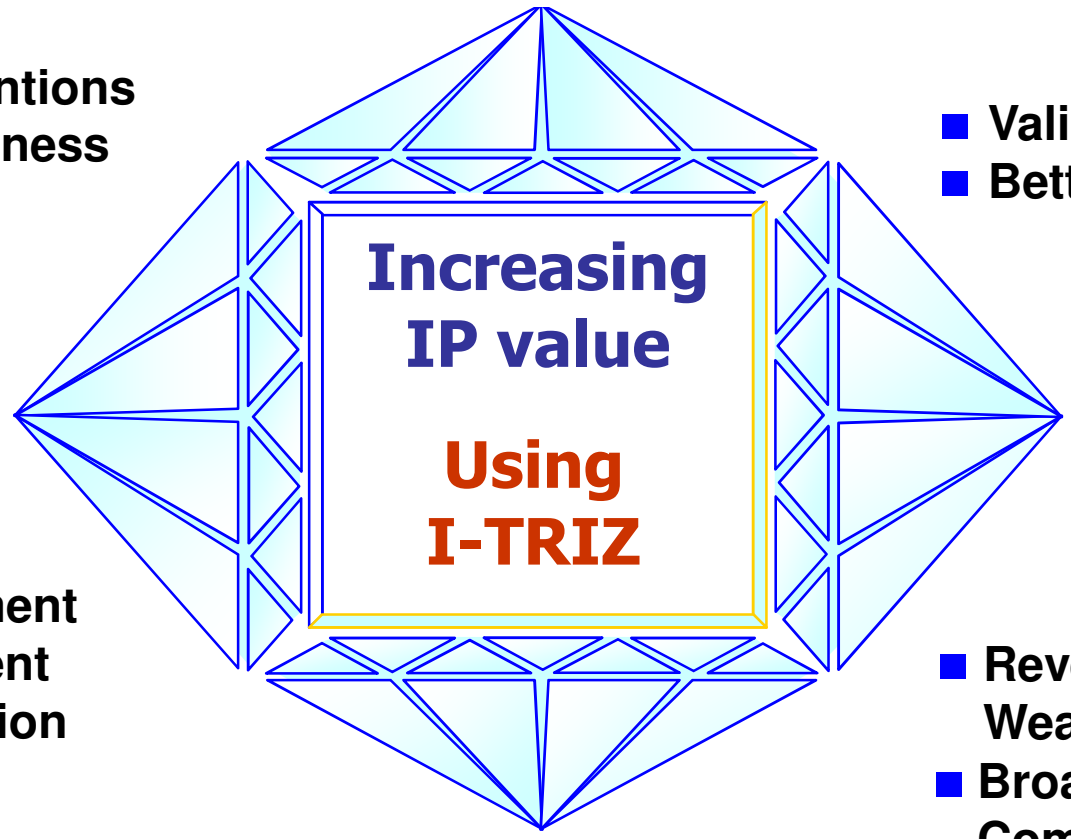
Copyright 2001-2012 Ideation International Inc.

Management of Intellectual Property

Evaluation and Enhancement of Intellectual Property

- **Disclosure Inspection Invention Evaluation**
  - **Validate Inventions**
  - **Better Patents**

- **Directed Evolution®**
  - **New Inventions**
  - **New Business**

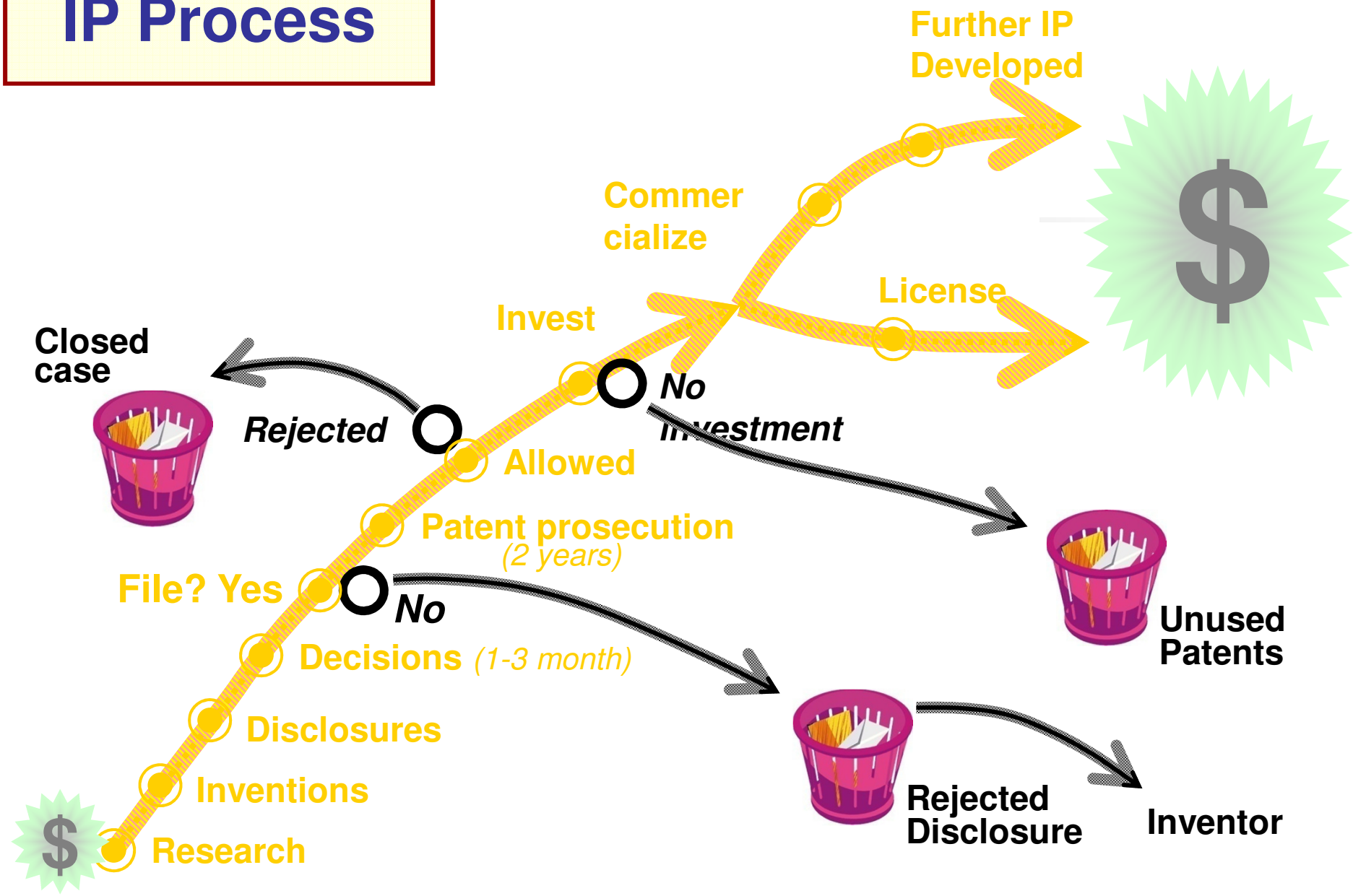


- **Invention Analysis**
  - **Reveal Strengths / Weaknesses**
  - **Broadest / Most Comprehensive Claims**

- **Patent Deconstruction®**
  - **Avoid Infringement**
  - **Circumvent Competition**

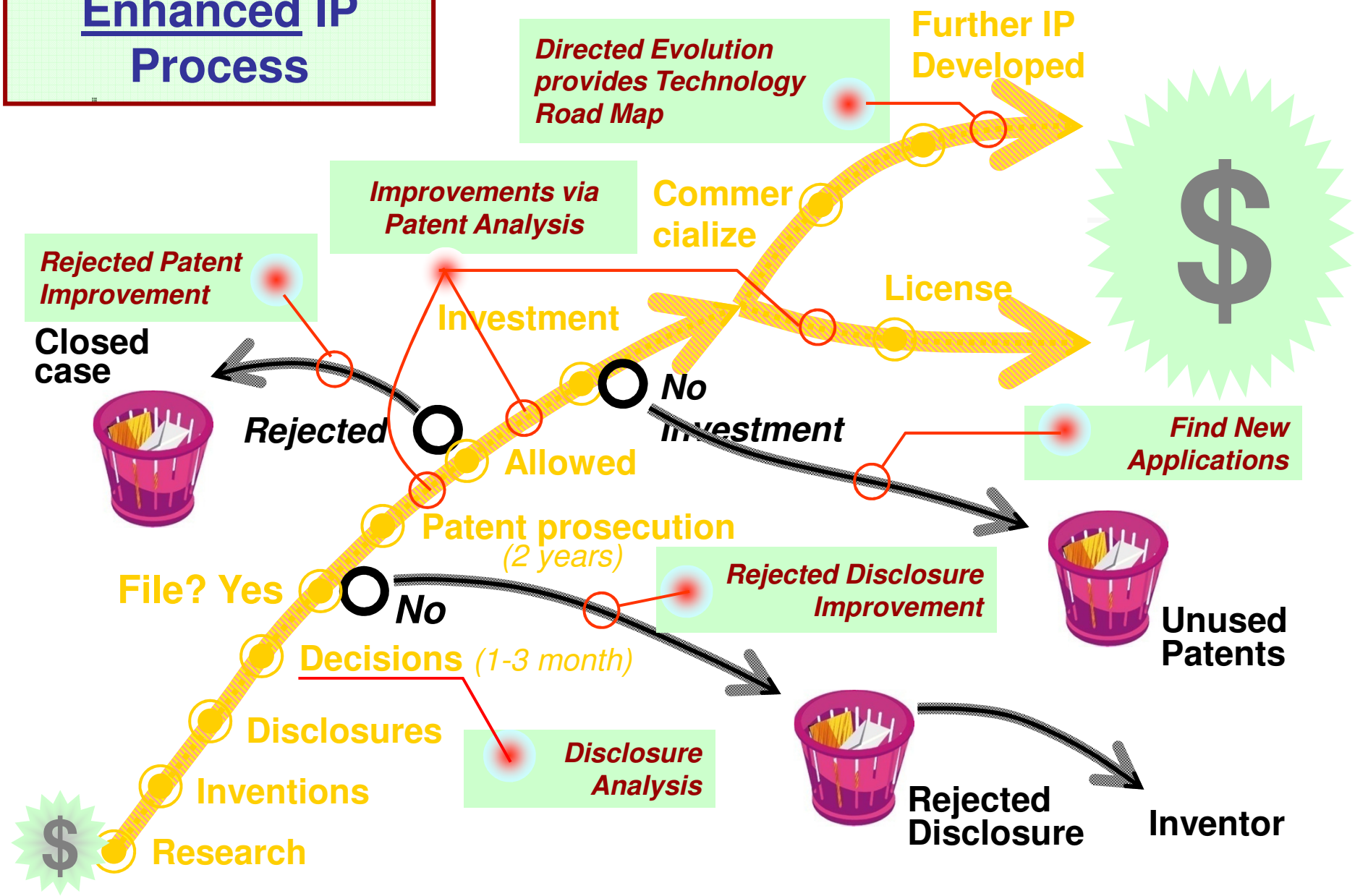
Copyright 2001-2012 Ideation International Inc.

IP Process



Copyright 2001-2012 Ideation International Inc.

Enhanced IP Process

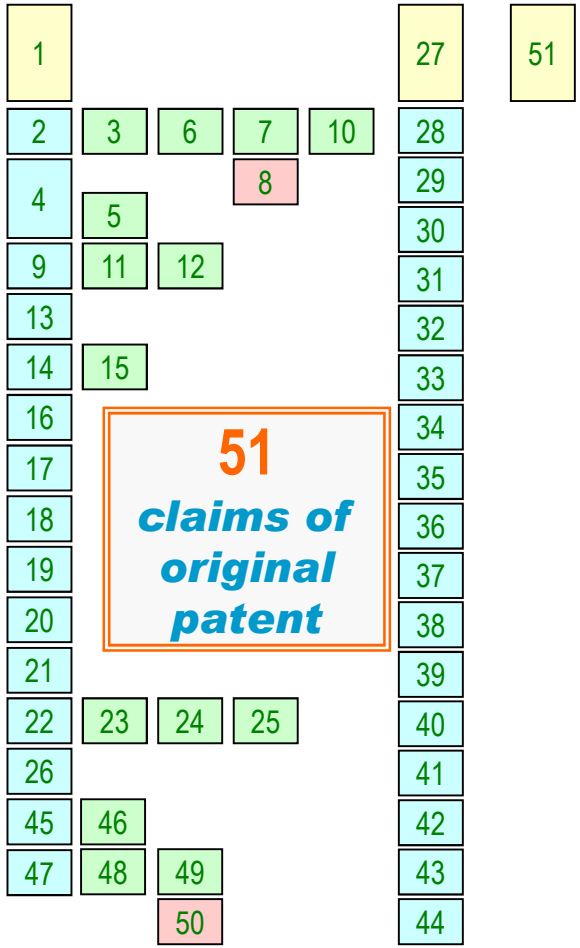


Copyright 2001-2012 Ideation International Inc.

Patent Fence For Chemical Formulation

Original Patent
Protected Resources

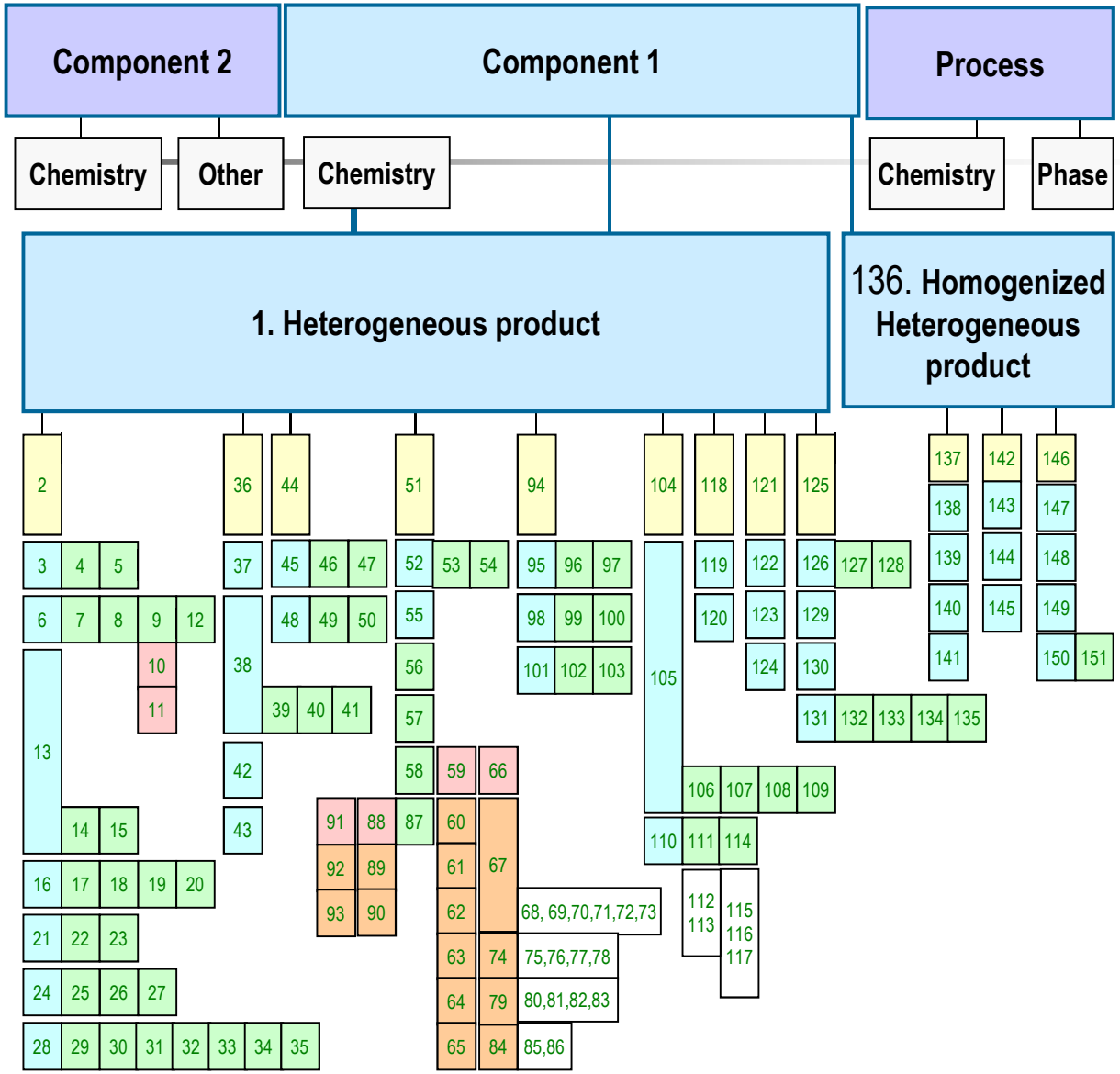
Component 1



Copyright 2001-2012 Ideation International Inc.

Additional Intellectual Capital

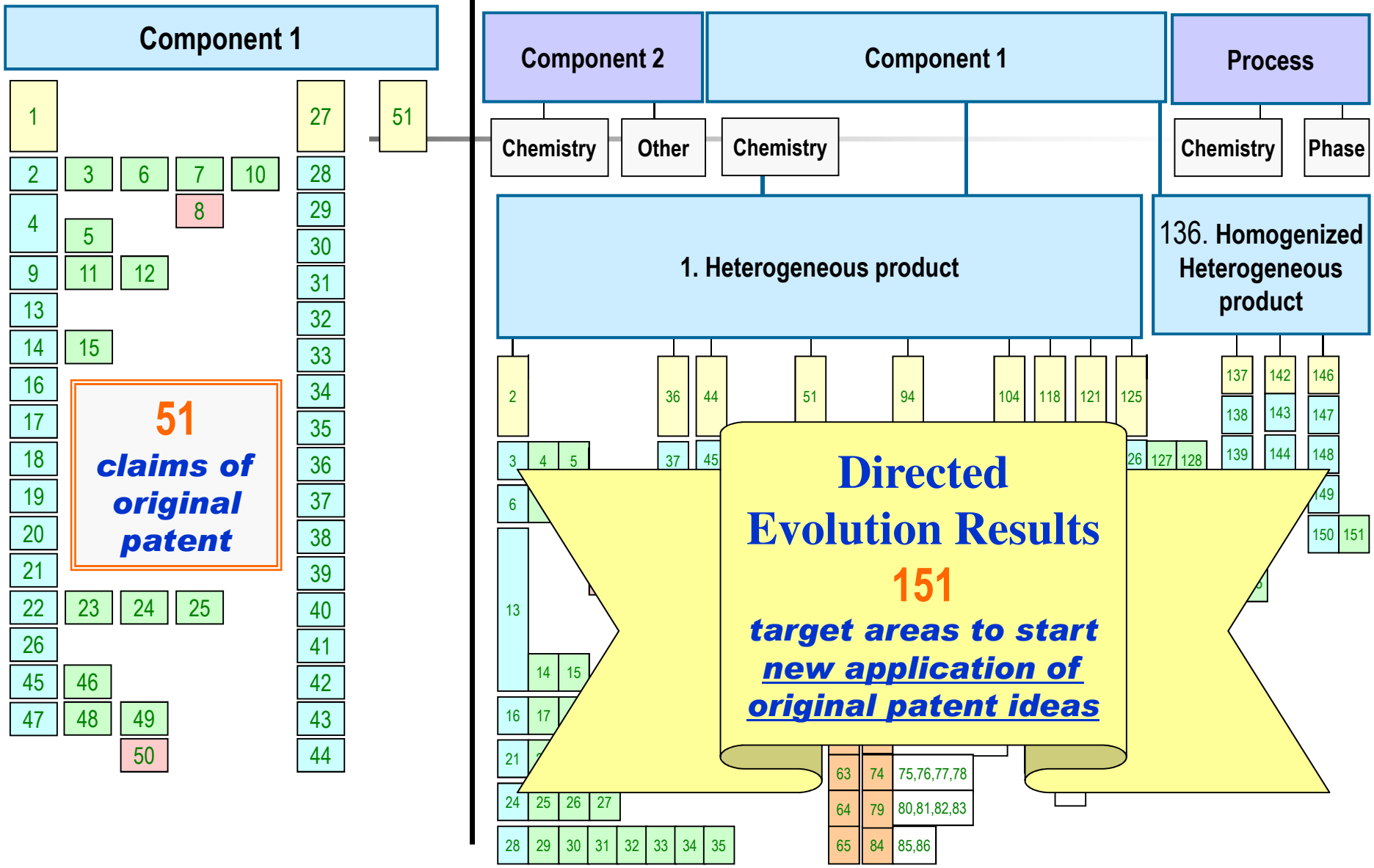
Evolutionary Resources Resulted from DE Application



Copyright 2001-2012 Ideation International Inc.

Original Patent
Protected Resources

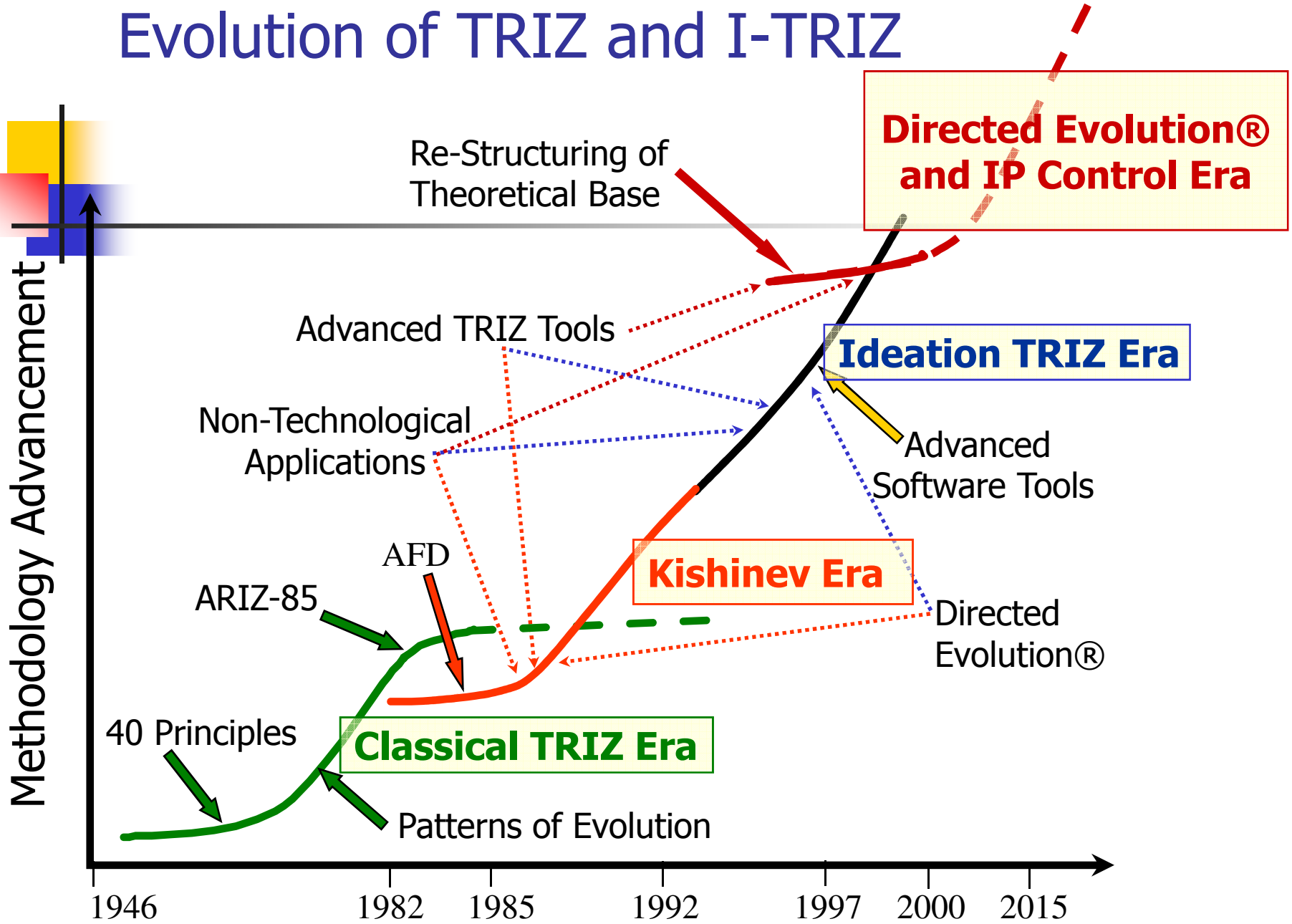
Additional Intellectual Capital
Evolutionary Resources



Copyright 2001-2012 Ideation International Inc.

Conclusions

Evolution of TRIZ and I-TRIZ



Copyright 2001-2012 Ideation International Inc.

Legend:
Classical TRIZ (in black)
Advanced by Ideation
Newly developed by Ideation

Summary Offering of the Ideation TRIZ Methodology versus Classical TRIZ

Four Original Key Findings

- Definition of the Inventive Problem
- Levels of Inventions
- Patterns of Inventions
- Patterns of Evolution

Three Main Premises

- **Contradictions**
- **Ideality & Resources**
- **System Approach**

Four Analytical Tools

- **Innovation Situation Questionnaire (ISQ)®**
- **Problem Formulator®**
- **Algorithm for Inventive Problem-Solving (ARIZ)**
- **Substance-Field Analysis (Su-Field)**

Ten Knowledge-Based Tools

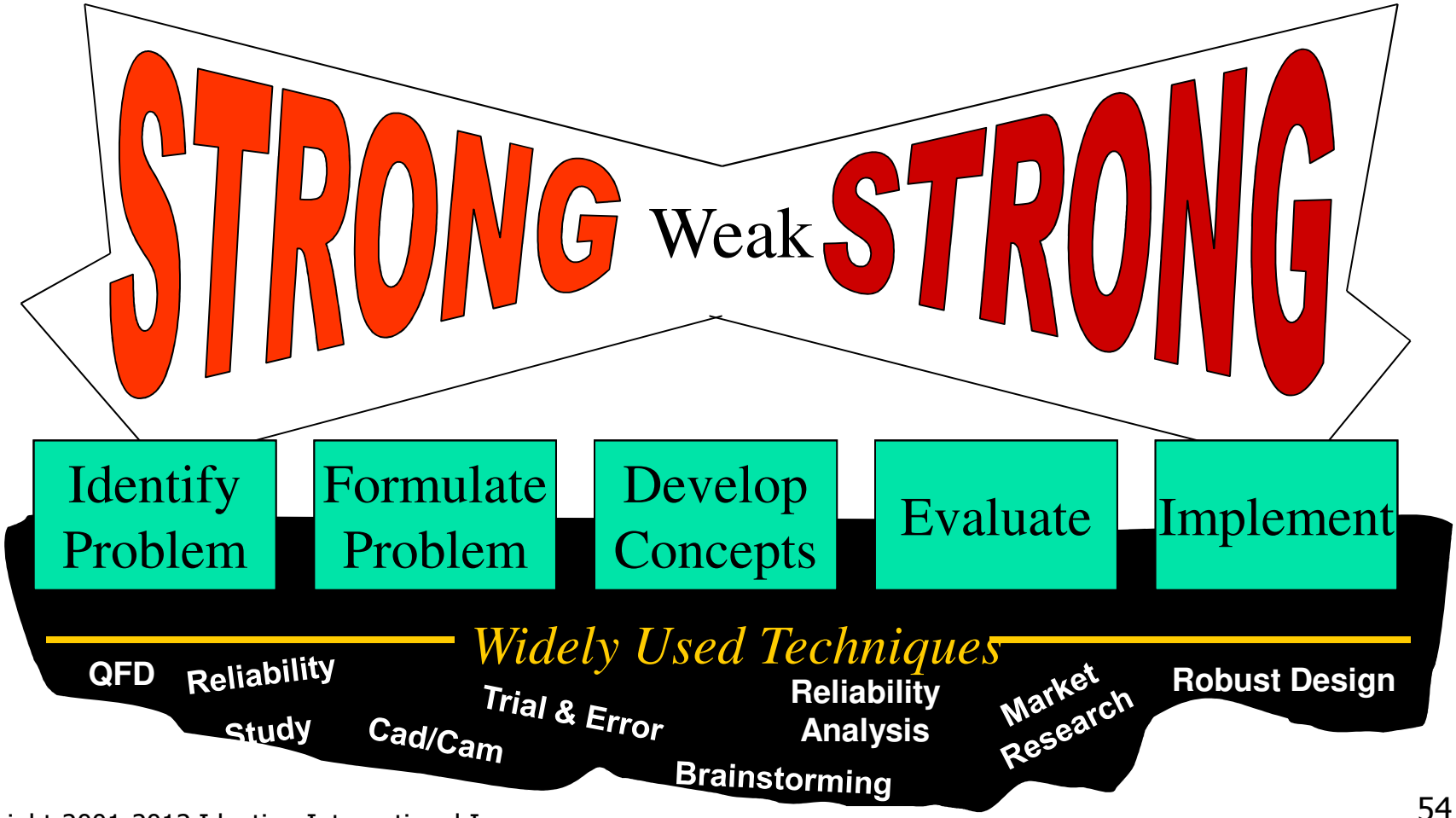
- 40 Principles & Contradiction Table
- Separation Principles
- 76 Standard Solutions
- Effects
- **Patterns/Lines of Evolution**
- **Selected Innovation Examples**
- **System of Operators**
- **Bank of Evolutionary Alternatives™**
- **AFD checklists**
- **IP checklists**

Four Main Applications

- **Inventive Problem Solving (IPS)**
- **Anticipatory Failure Determination (AFD)**
- **Directed Evolution (DE)®**
- **Management of Intellectual Property**

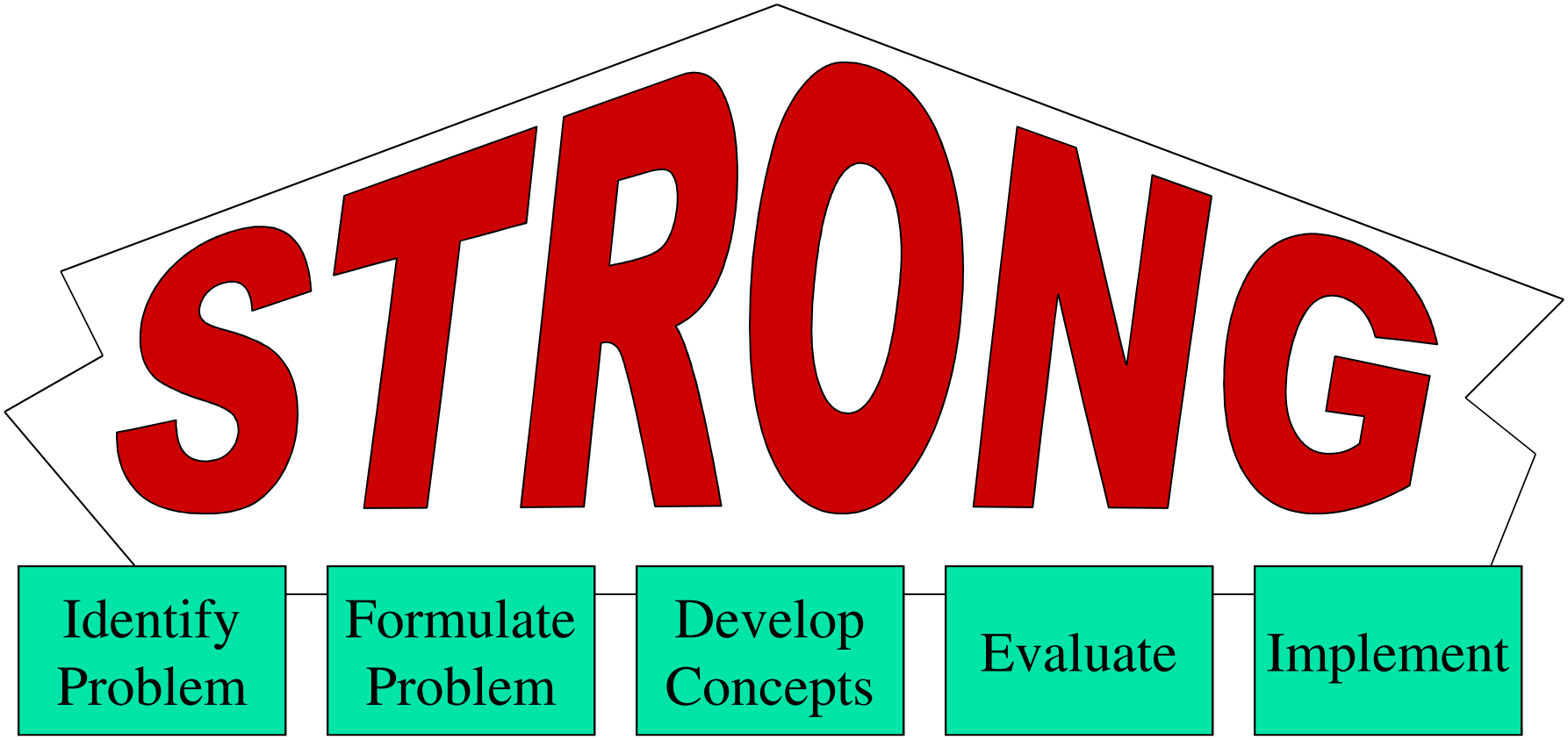
Copyright 2001-2012 Ideation International Inc.

Traditional Innovation Process



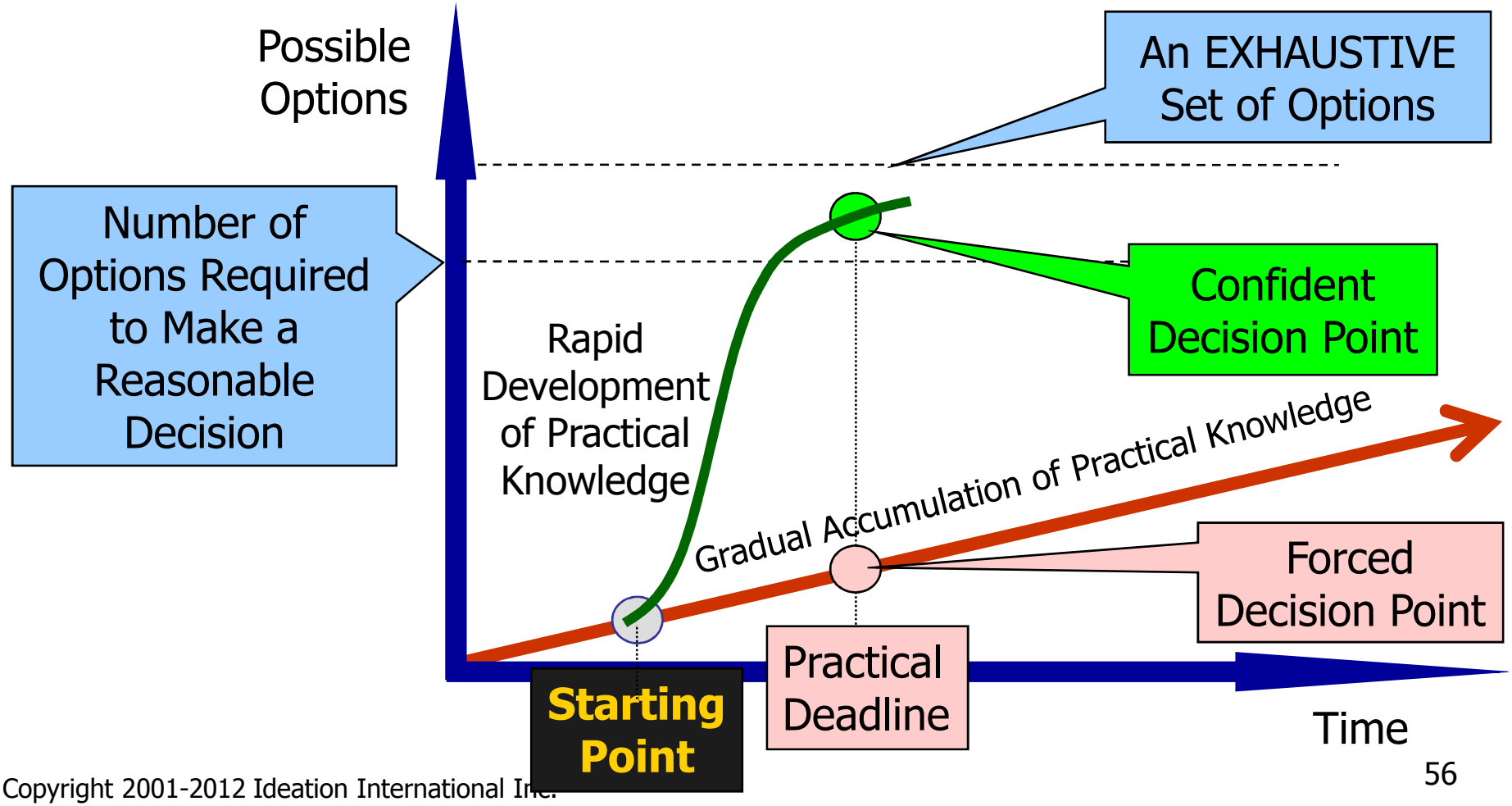
Copyright 2001-2012 Ideation International Inc.

The Added Value of Ideation TRIZ



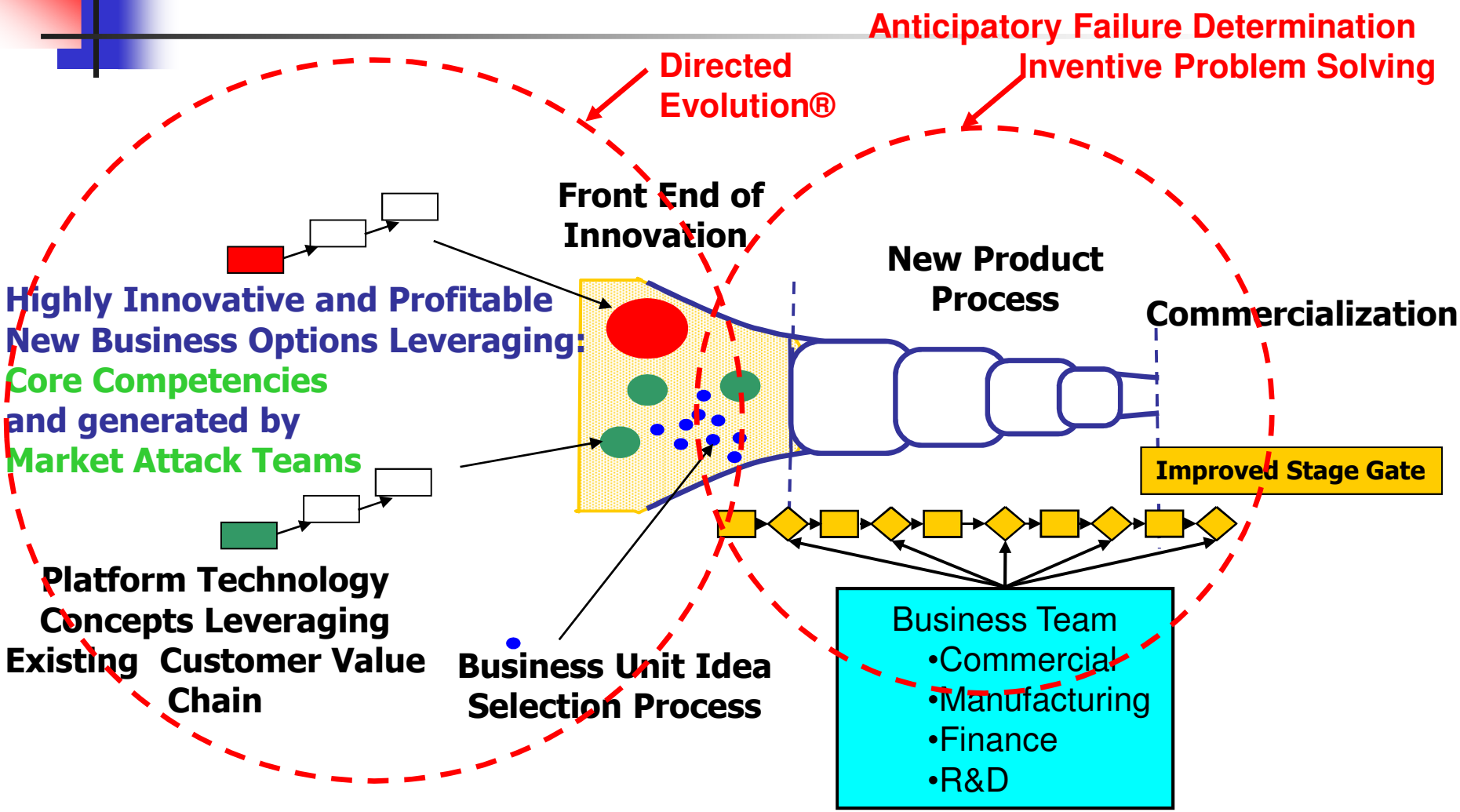
Copyright 2001-2012 Ideation International Inc.

Achieving the Ideal Vision: Accelerating Innovation via Structure



Copyright 2001-2012 Ideation International Inc.

Structured Innovation Process



Copyright 2001-2012 Ideation International Inc.

Ideation International Overview

- Established in November of 1992 as a Delaware corporation
- Provider of TRIZ-based services and products
- Acquired leading TRIZ School in Russia (The Kishinev School)
- Headquartered in Farmington Hills, MI
- Includes world's most experienced group of TRIZ masters and certified TRIZ specialists
- Conducted business with over 5000 enterprises worldwide
- Active in 40 countries and 60 universities
- Has trained over 250,000 individuals worldwide
- Conducts continuous research/advancement of TRIZ methodology

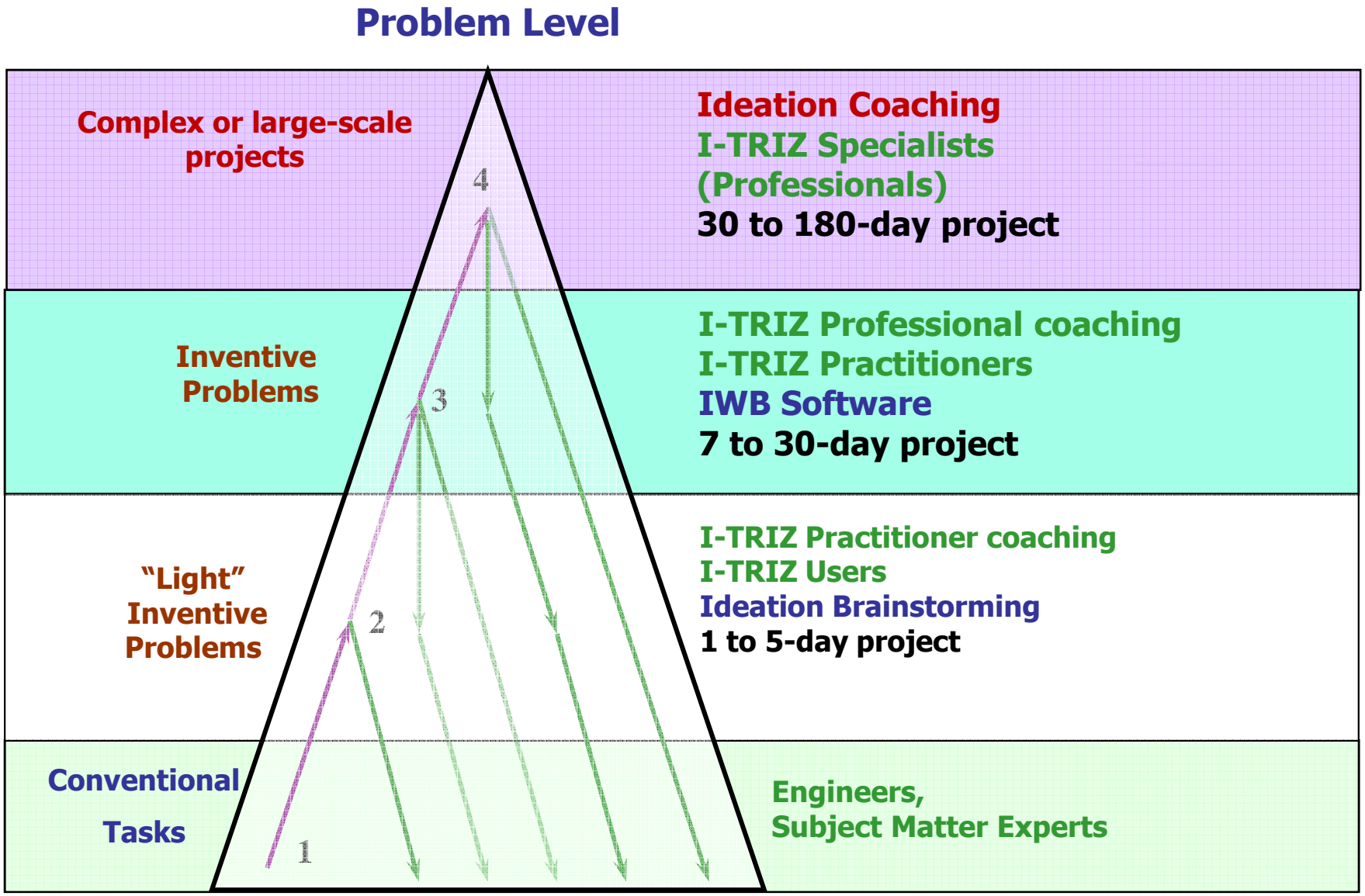
Copyright 2001-2012 Ideation International Inc.

What does Ideation offer?

I-TRIZ Application/process	Education	Software	Publications	Analytical Services	Age of Application
Inventive Problem Solving	★	★	Multiple books and paper	★	65 yrs
Failure Analysis	★	★	Two books multiple papers	★	30 yrs
Failure Prediction	★	★	Two books multiple papers	★	30 yrs
Directed Evolution	★	Internal use	One book multiple papers	★	20 yrs
Enhancement of Intellectual Property	★	Internal use	Multiple papers	★	10 yrs

Copyright 2001-2012 Ideation International Inc.

The Ideation TRIZ System Pyramid



Copyright 2001-2012 Ideation International Inc.

TRIZ is not a Magic Wand

Innovation Success $= P_c \times P_{kn} \times P_m \times M_s \times (1+C_{I\text{-}TRIZ})$

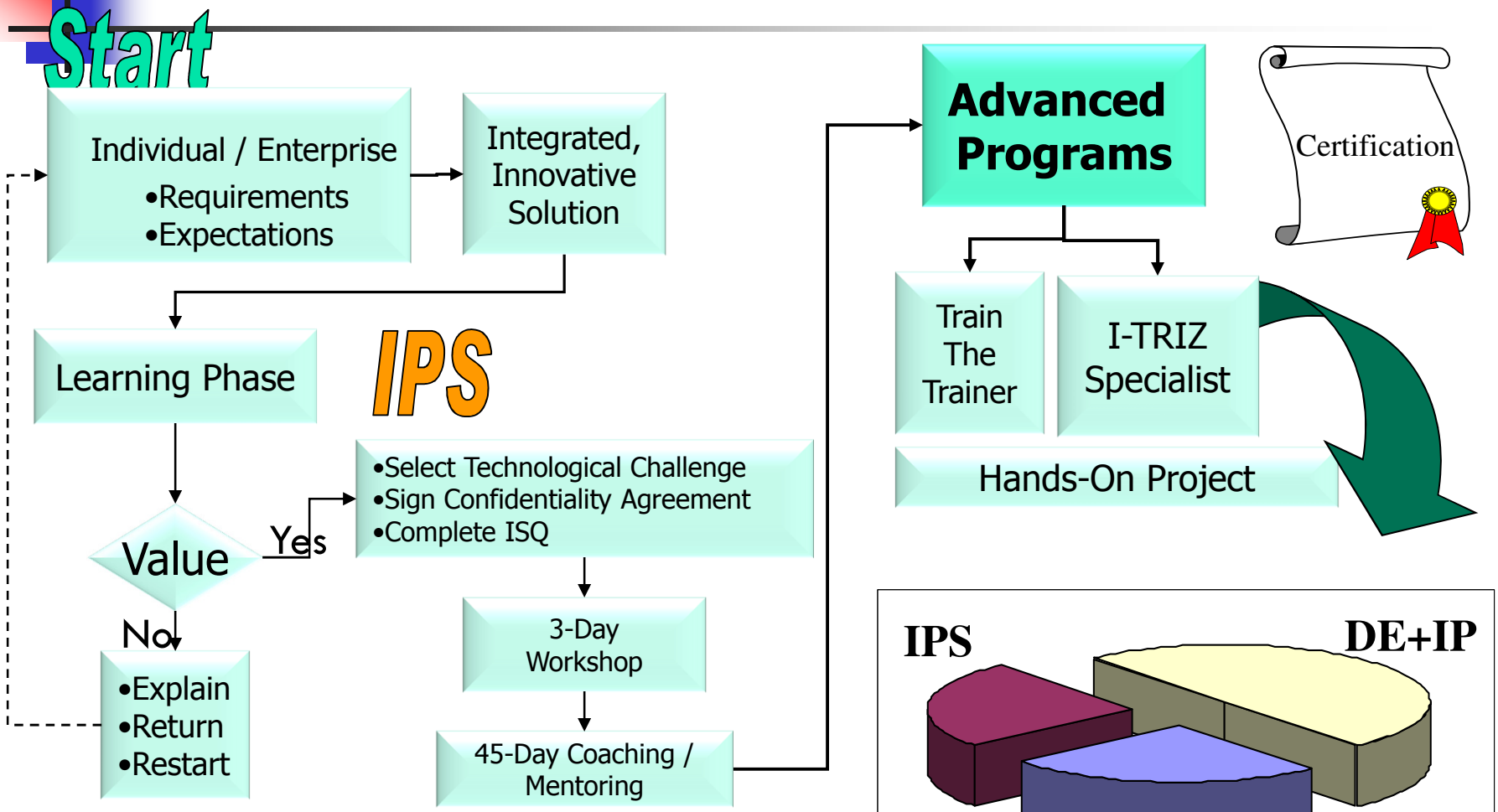
P_c = Personal Capabilities;
P_{kn} = Personal Knowledge;
P_m = Personal Motivation;
M_s = Management support;

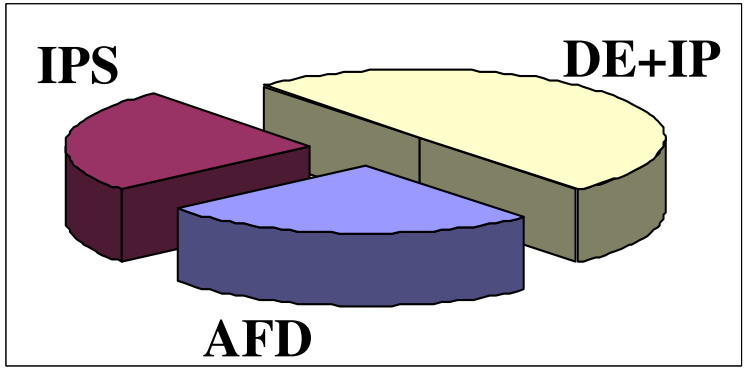
$C_{I\text{-}TRIZ}$ = factor depending on I-TRIZ training, tools and personal experience in their utilization.

$C_{I\text{-}TRIZ}$ can be between 0 and hundreds.

Copyright 2001-2012 Ideation International Inc.

Mastering the Ideation TRIZ Methodology and TRIZSoft®





Copyright 2001-2012 Ideation International Inc.