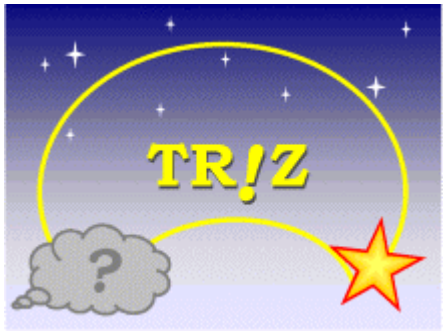
A Talk presented to
Faculty members of OGU



Creative Problem-Solving Methodologies TRIZ/USIT: Overview of My 14 Years in Research, Education, and Promotion

March 17, 2012

Toru Nakagawa

Faculty of Informatics
Osaka Gakuin University

1. Introduction: Brief Biography and Today's Talk

1963-1980 Univ. of Tokyo: Physical Chemistry, Research on molecullar structure

1980-1998 Fujitsu Co.: Research in Software QC, (later) research supporting staff

1998-2012 Osaka Gakuin Univ.: Research, education, and social promotion of TRIZ

1997 Encountered TRIZ; Introduced TRIZ into Fujitsu Labs.

1998 Professor of Osaka Gakuin Univ.; Started "TRIZ Home Page in Japan".

1999 TRIZ Conference (USA); Introducing USIT; Trip to Russia & Belarus

2000 OGU Faculty of Informatics; Japanese edition of Salamatov's "TRIZ"; USIT Training

2001 ETRIA TRIZ Future Conf. (Europe); Lecture of 'Scientific Information Methodoogy'

2002 Research on 'USIT Operators'

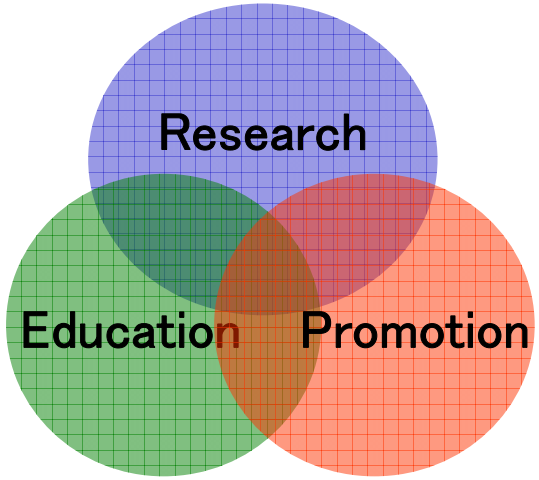
2004 Japanese edition of Mann's "Systemtic Innovation";
Research on 'Six-Box Scheme' for creative problem solving

2005 Start of Japan TRIZ CB; First TRIZ Symposium in Japan

2007 Start of Japan TRIZ Society, NPO.

2008 Seminar IB class (using "7 Habits")

2012 Retiring Osaka Gakuin Univ.



Motive： Methodology for Creative Problem Solving

How Can We Break-through Barriers in Technology?

-- Conventionally:

Get an Enlightenment !

Results of researches on historical cases of scientists and inventors:

- Having basic knowledge, and studying & working in the area,
- Thinking over for a long time with a strong awareness of the problem,
- On a reluxed occasion, an enlightenment was hit with a small trigger.
- Applied the idea to the problem and built up a solution.

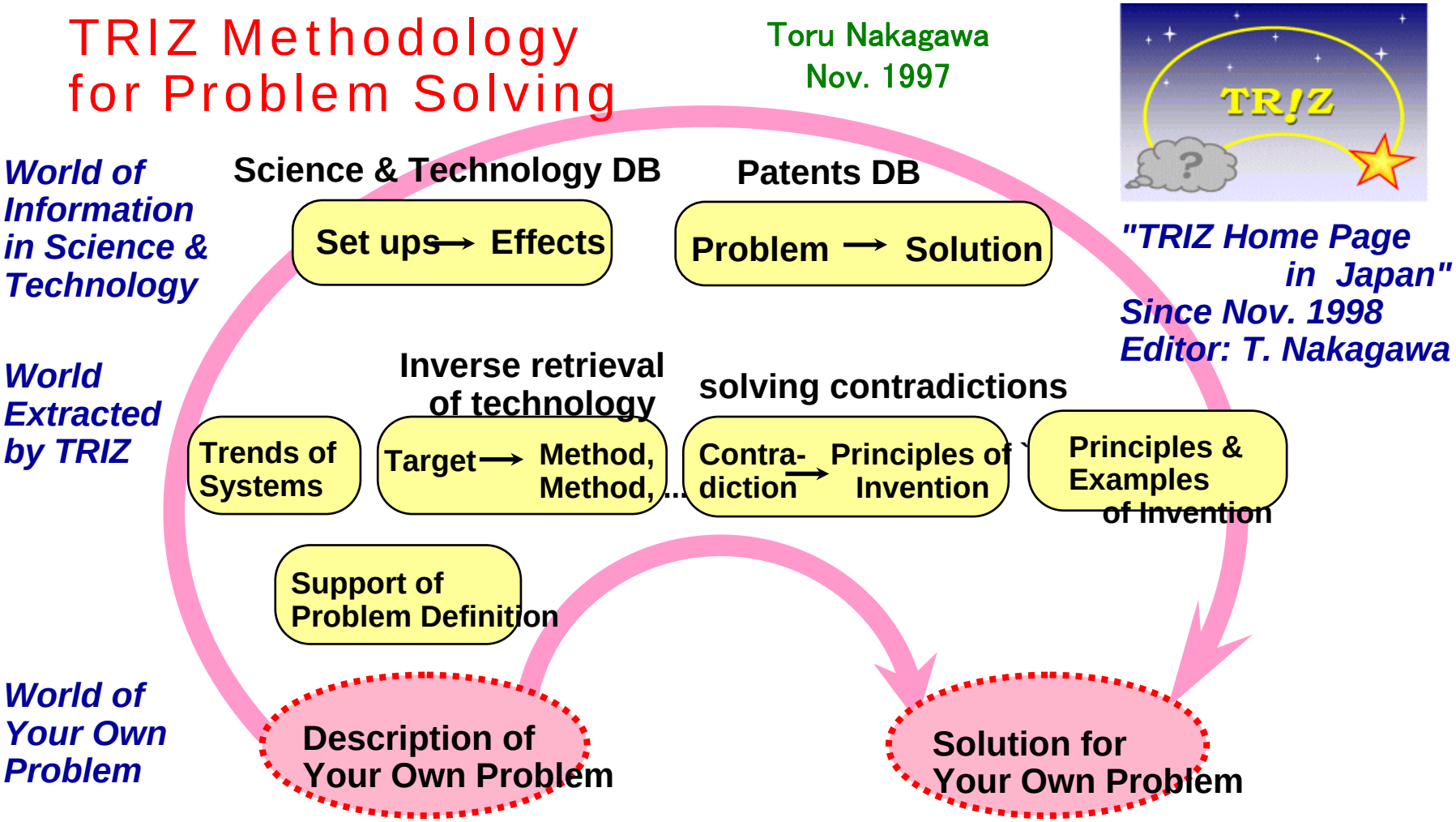
However, no assurance when and whether It will come.

Thus, it is necessary to work hard, to do a lot of trials-and-errors,
To try to get ideas by means of brainstorming, etc.
To look around for some hints,
To think reverse (up-side down), to think flexibly, ...

Can we have any method more scientific, systematic, and sure?

2. Research: TRIZ → USIT → New Paradigm

2.1 TRIZ (Theory of Inventive Problem Solving)



40 Inventive Principles of TRIZ

==> Familiar expressions: "Idea Pop-up Cards"

by Rikie Ishii (Miyagi TRIZ Study Group) Japan TRIZ Symposium 2007

1. Divide it.
2. Separate it.
3. Change a part of it.
4. Make it unbalanced.
5. Join the two.
6. Make it useful for others.
7. Put it inside.
8. Make it balanced.
9. Step back before you go.
10. Expect and prepare beforehand

Essence of TRIZ in 50 Words

Toru Nakagawa
TRIZCON2001, Mar. 25-27, 2001

Essence of TRIZ:

Recognition that

technical systems evolve

towards the increase of ideality

by overcoming contradictions

mostly with minimal introduction of resources.

Thus, for creative problem solving,

TRIZ provides with a dialectic way of thinking,

i.e.,

to understand the problem as a system,

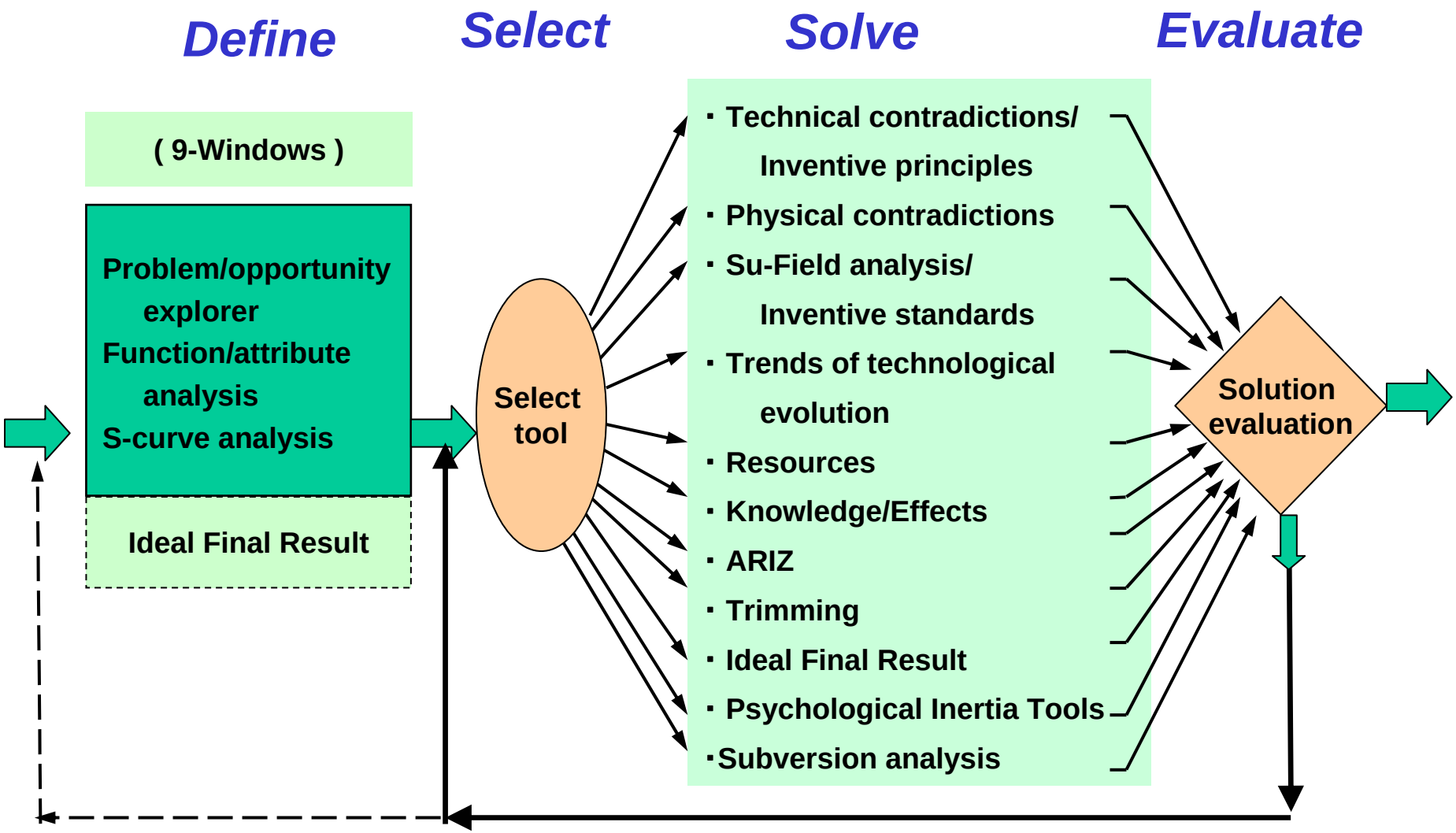
to make an image of the ideal solution first, and

to solve contradictions.

TRIZ is huge and complex, people often say, but its essence is easy to learn and understand.

Overall Procedure in TRIZ

Darrell Mann's "HOSI" (2002)



You may learn one by one as you need. (Mann)

We need a simpler and straightforward method. (Nakagawa)

TRIZ Contradiction Matrix

Problem Formalization in 'Technical Contradiction':

"When we want to improve the system in one aspect in some manner, another aspect of the system gets worse to an unallowable degree."

By the analysis of a huge number of patents, most frequently-used inventive principles were revealed for each type of technical contadiction in the matrix:

Genrich Altshuller (1971) Matrix of 39 × 39

Darrell Mann et al. (2003) Matrix of 48 × 48 (<= All US patents granted in 1985-2002)

Improving Parameter \ Worsened Parameter	...	45. Complexity of the System	46. Complexity of control	...
...				
28. Loss of information		6, 25, 13, 24	10, 6, 25, 2, 3	
...				
32. Adaptability/ versatility		6, 28, 29, 31	28, 25, 37, 19	
...				

Suggested Inventive Principles:

6: Versatility, 25: Self-service, 28: Mechanism substitution, etc.

2.2 USIT (Unified Structured Inventive Thinking)

USIT was developed by Ed Sickafus (USA) in 1995 under influence of TRIZ. It has a straightforward process with unified concepts and methods.

Strategies for Introducing TRIZ into Industries

Hurry and Forcing	Slow but Steady (Nakagawa, 2000)
In a complete form of the whole TRIZ,	Starting with the understandable parts of TRIZ,
Using the full ARIZ algorithm,	Using USIT process (I.e. a simplified TRIZ),
Teaching system analysis, from the beginning,	Using TRIZ data base and USIT, at the beginning,
With top-down leadership organization,	With bottom-up grass-root organization,
Ordering to all/many employees,	By groups of volunteer employees,
Changing current R&D style drastically,	Introducing into the current R&D activities,
Believing in its effectiveness,	Proving its effectiveness by ourselves,
Rapidly, extensively, and widely	Without hurrying; steadily, and deeply

"USIT Oprators": A system of solution generaton methods

-- Obtained by re-organizing all the solution methods in TRIZ

T. Nakagawa, H. Kosha, and Y. Mihara (ETRIA 2002)

TRIZ methods for Solution Generation

USIT Operators

(5 Main-, 32 sub-methods)

40 Inventive Principles

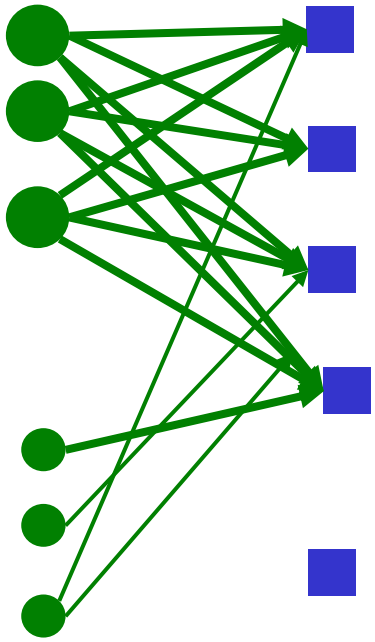
76 Inventive Standards

35 Trends of System Evolution

Separation Principle

Self-X Principle

Trimming



Object Pluralization

Attribute Dimensionality

Function Distribution

Solution Combination

Solution Generalization

USIT Operators are further classified in a hierarchical way.

An example of USIT Operator sub-method

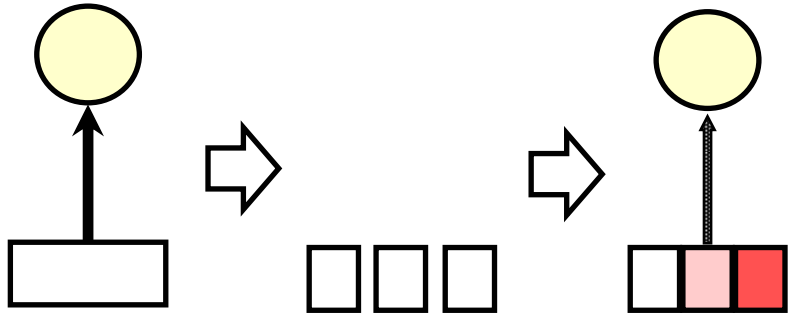
(1) Object Pluralization Method

(1c) Divide the Object (into 1/2, 1/3, ..., 1/∞).

Divide the Object into multiple parts (1/2, 1/3, ..., 1/∞),
modify the parts (slightly,
or differently for different parts),
and combine them for using together in the system.

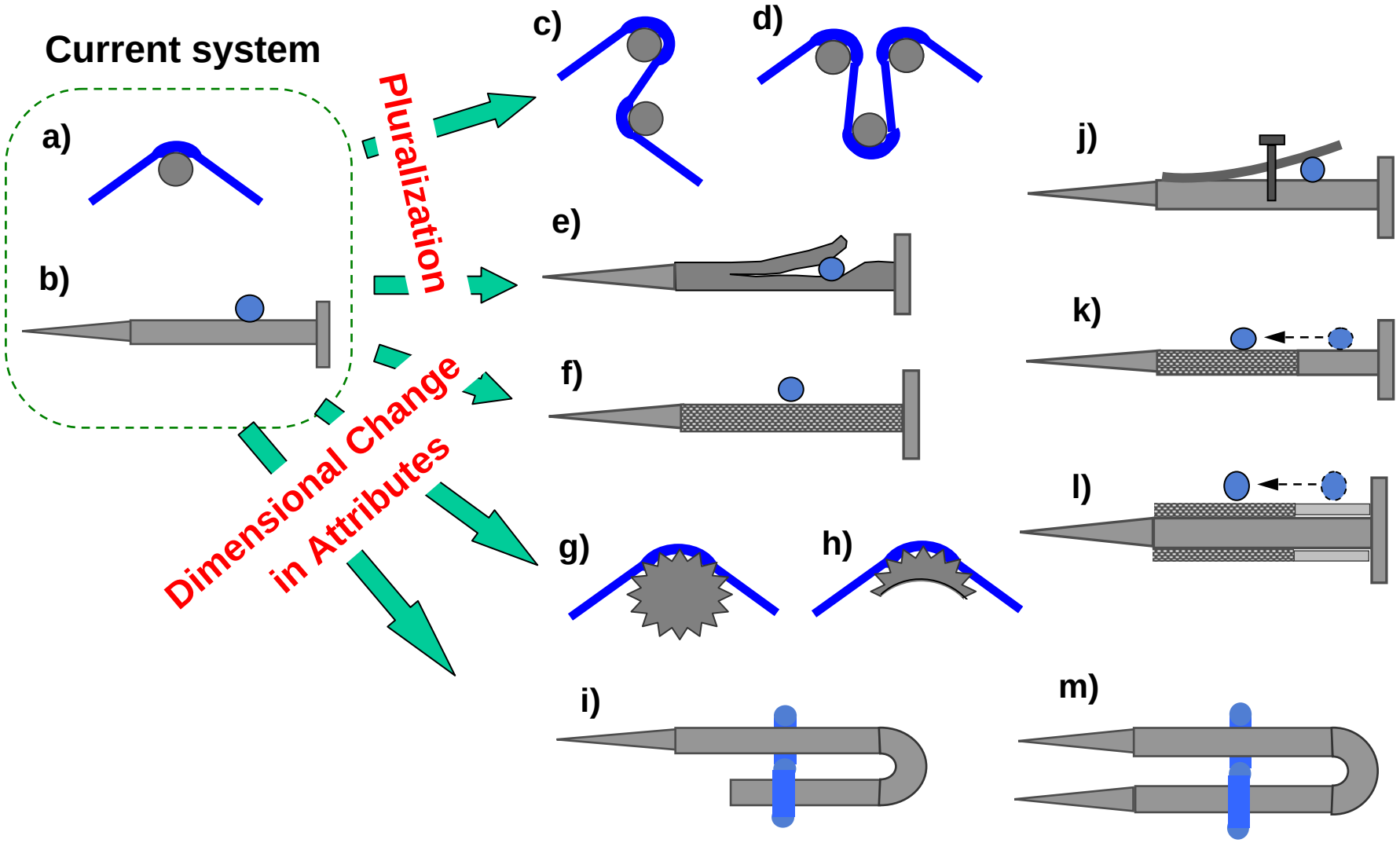
TRIZ Inventive Principles
which brought this sub-method:

- P1. Segmentation
- P2. Taking away
- P3. Local quality
- P15. Dynamicity



Examples of Application of USIT Operators: (Part)

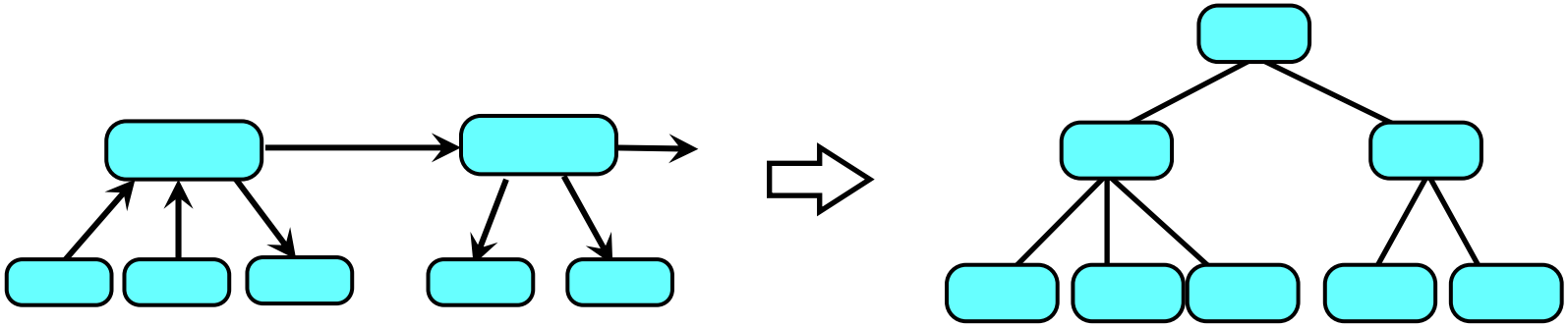
Picture Hanging Kit Problem. USIT Operators are applied to the nail.



(5) Solution Generalization Method in USIT

Represent a solution in a more general way,
form a solution template, and
obtain concepts of solutions
in the associative manner.

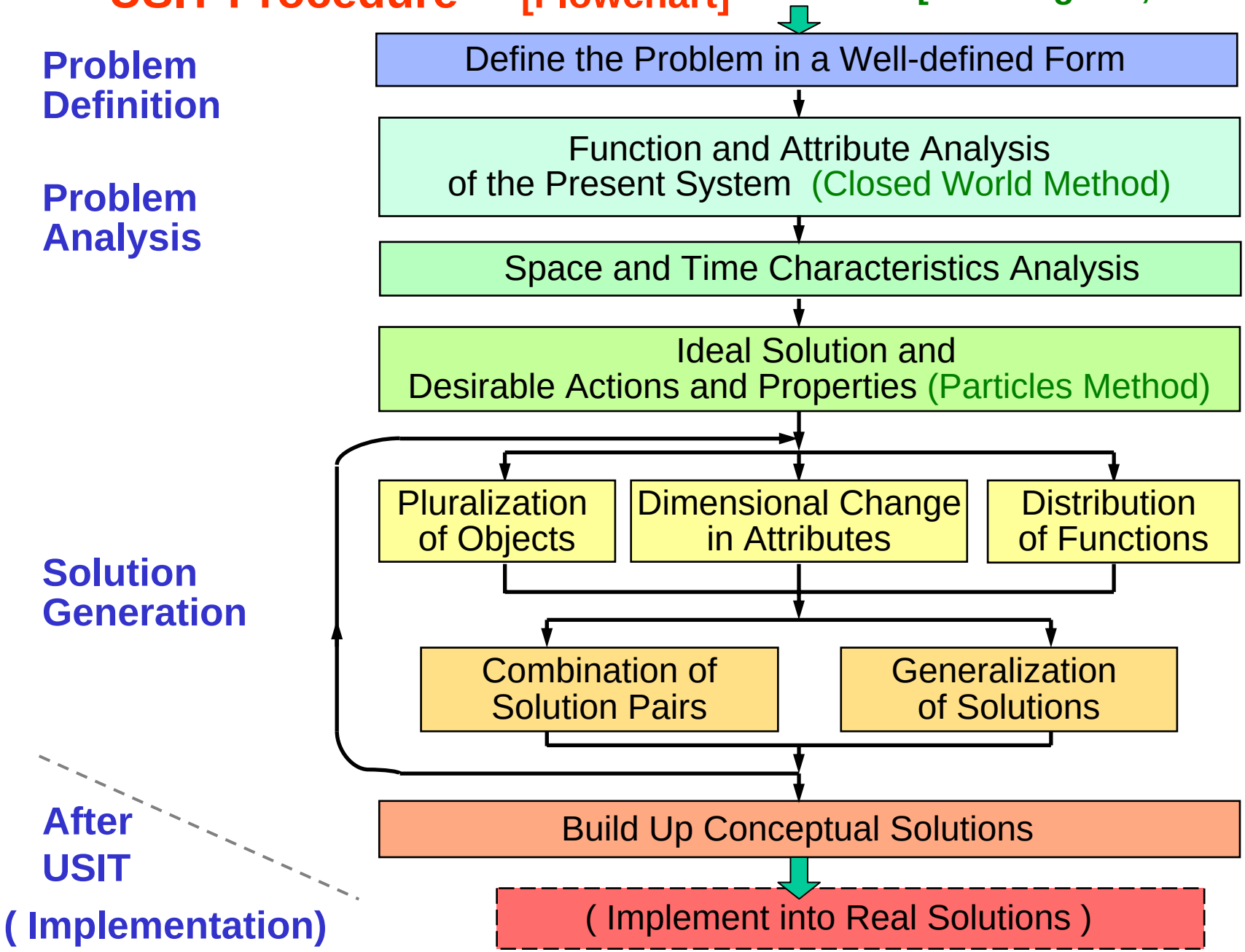
Also generate a hierarchical system of solutions.



➡ USIT (i.e., a simple and unified TRIZ)
analyzes any problem in a standard process and
generates solutions systematically and comprehensively.

USIT Procedure [Flowchart]

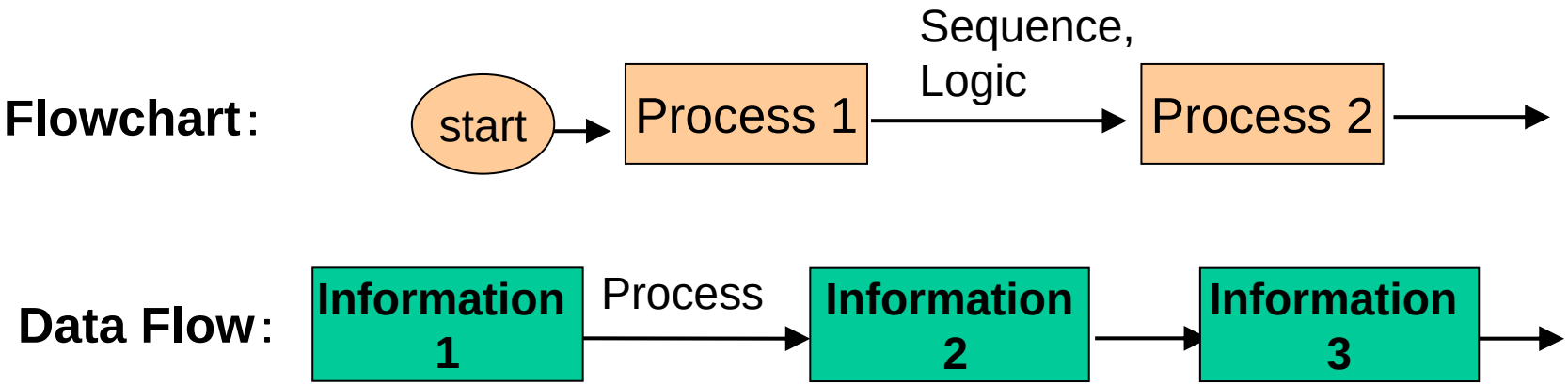
[T. Nakagawa, Mar. 2005]



2.3 Six-Box Scheme: A New Paradigm for Creative Problem Solving

We repesented the USIT procedure in Data Flow Diagram.

(T. Nakagawa, Sept. 2004)



Facts well known in computer science:

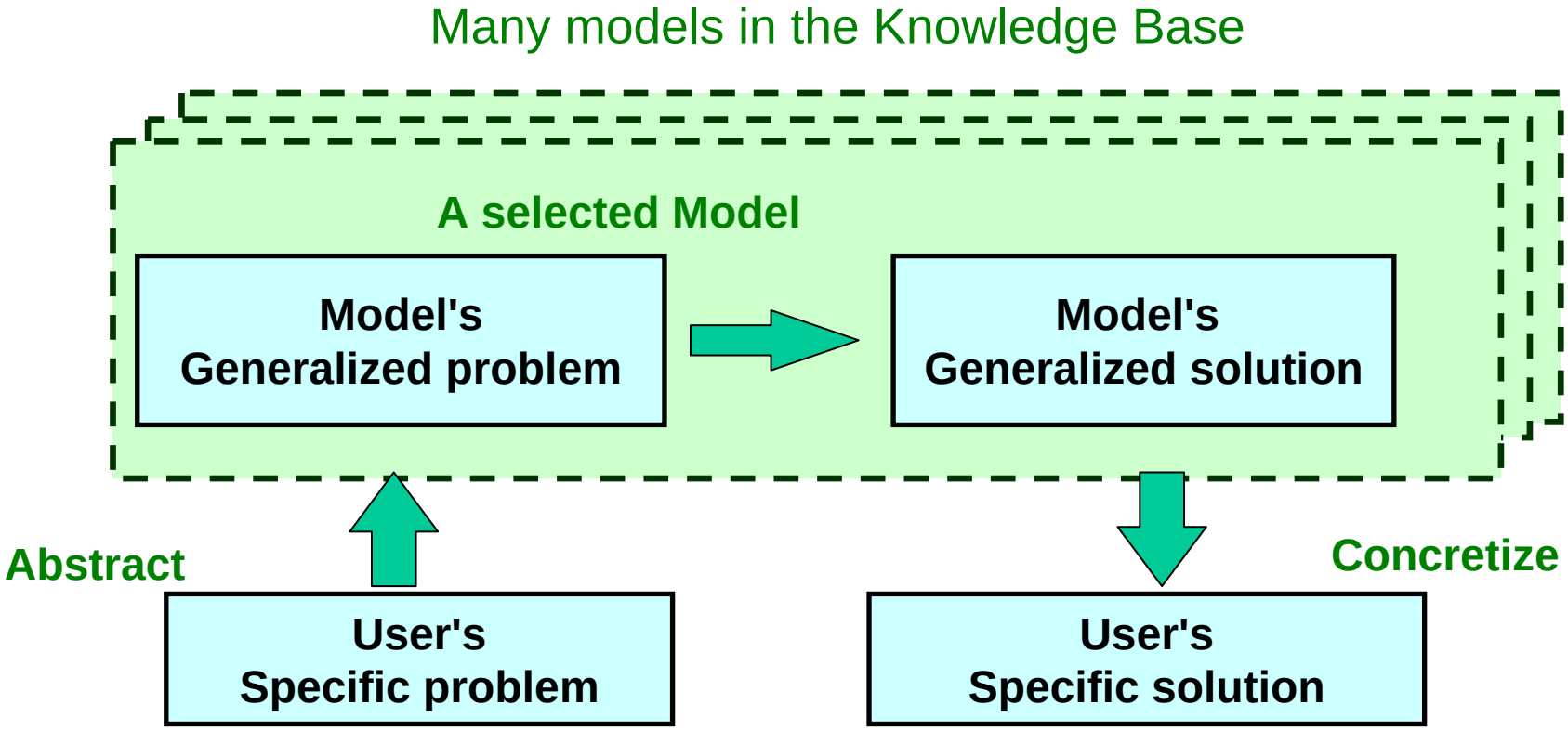
Data Flow describes the in/out and intermediary information as requirements.
There may be different methods (How) for achieving such requirements (What)
Flowcharts try to describe the means (How) to perform.
The information to be handled are implicit, not specified explicitly.

Data Flow representations are more basic and stable than the Flowcharts.

Basic scheme for Problem Solving
(Conventional: "Four-Box Scheme)

Science & Technologies (Many models, specialized in areas)

==> (Traditional) TRIZ (**Across areas**, but many separate tools)



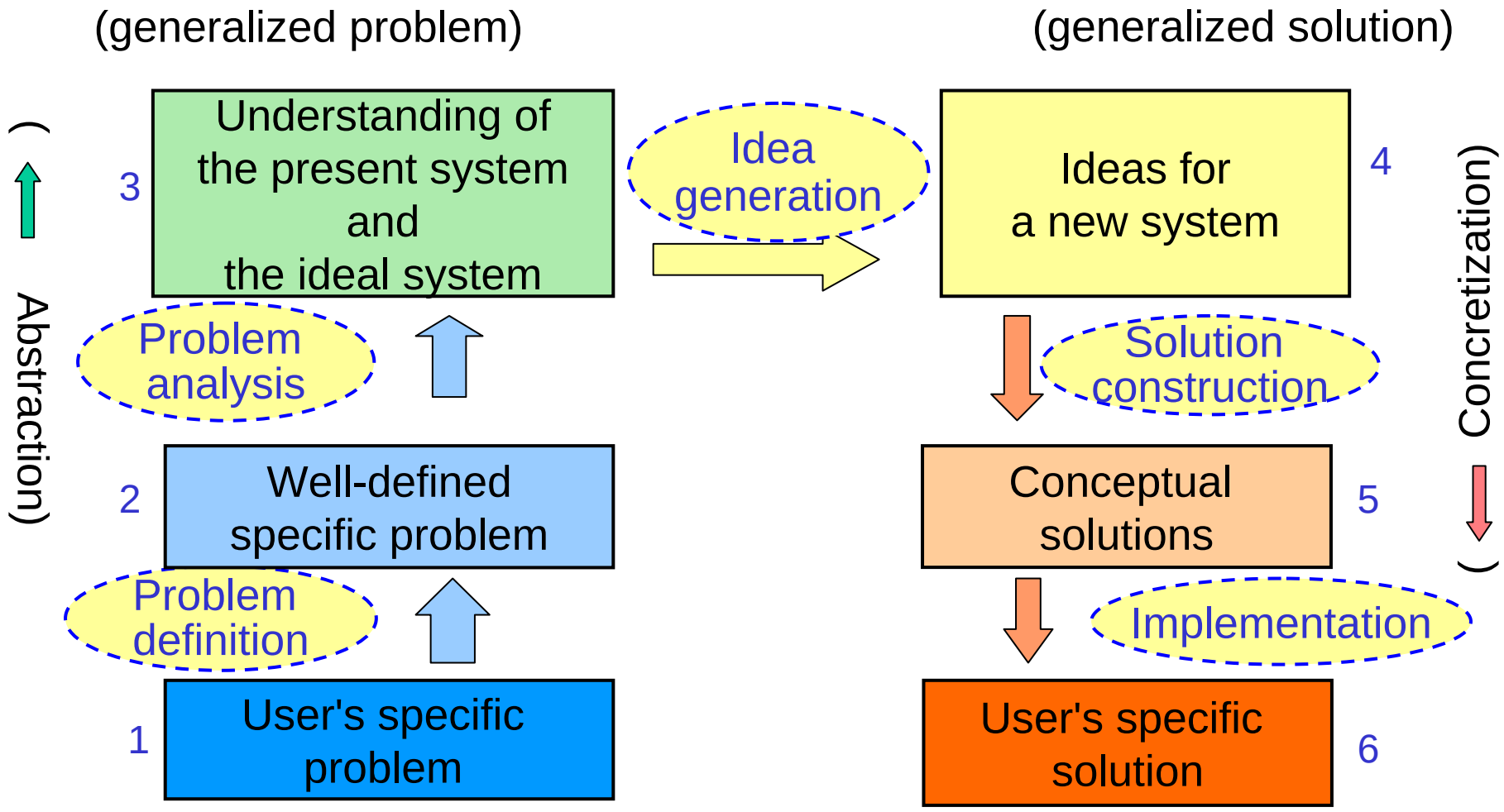
Problem is analyzed in an aspect and mapped onto a model.

⇨ Partial and insuficient analysis.

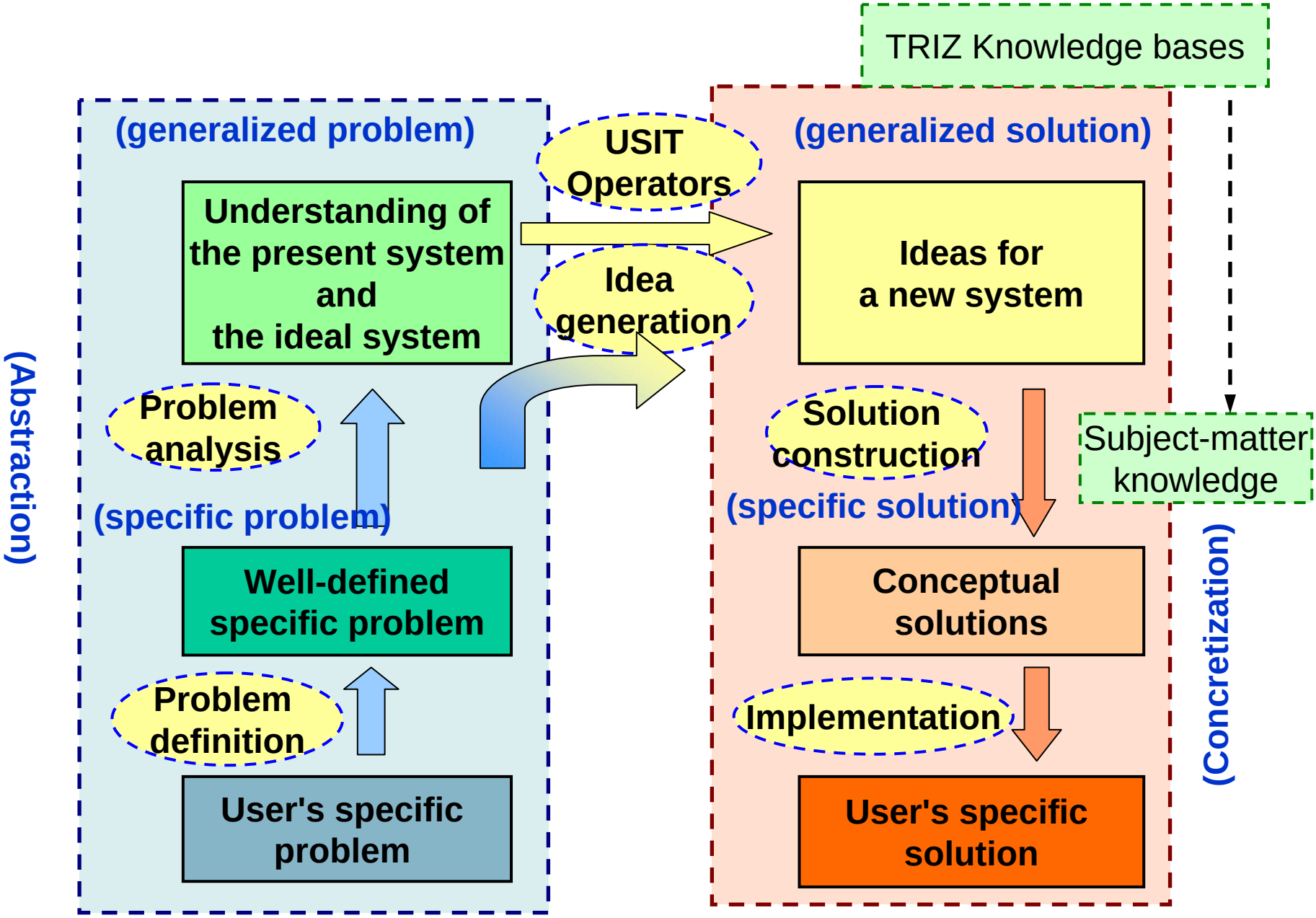
Six-Box Scheme of USIT: Data-Flow Representation

New Paradigm for Creative Problem Solving

A unified method across the fields



6-Box Scheme of Creative Problem Solving (USIT)



3. Education: Education of Creativity and Independence

Main subjects I taught at OGU:

- Information processing exercise (for all other faculty students)
- Computer science (for all other faculty students)
- Introduction to information science (1st year students; 2000-2003)
- Numerical computation (3rd year students)
- Software engineering (3rd year students)

● **Scientific information methodology (2nd year students, 2nd term)**

- Seminar I (1st year) ==> ● **Seminar IB (1st year, 2nd term)**
- Seminar IIA (2nd year, 1st term)

● **Seminar III (3rd year students)**

● **Seminar for Thesis (4th year students)**

3.1 Lecture Class: 'Methodologies of Creative Problem Solving'

15 Lectures (for 90 minutes each) to 2nd(+) year students:

(1) An easy introduction with simple case studies

(2) Three principal approaches in science & technology
third approach: Problem Solving.

(3) Finding the problem and its focus

(4) How come up with ideas? Enlightenment, Brainstorming.

(5) What are 'Systems'

-- Problem Analysis --

(6) Finding root causes of the problem

(7) Analyzing functions and attributes of the system

(8) Extra: How to construct and write a report.

(9) Analyzing space/time characteristics and ideal solution
(Particles Method)

-- Solution Generation --

(10) Fully utilizing knowledge bases: TRIZ Knowledge bases

(11) How to break through the barriers:

Physical Contradictions and TRIZ Separation Principles

(12) A system of solution generation operators:

USIT Operators

-- Summing Up of the Class --

(13) Case studies of everyday-life problem solving

(14) Creative problem solving with USIT

(15) Creative problem solving with TRIZ

-- Conclusion of the Class--

3.2 Seminar on 'Creative Problem Solving Thinking'

Learn various cases of solving familiar problems,
do the group exercises, and
work on some individual themes of problem solving in their thesis work.

Case studies: [● Presented by students、○ Presented by Nakagawa at Conferences and HP.]

○ 'Future evolution of mobile phones' (T. Kasahara, 2004) -- 9-window method.

○'How to prevent the stapler needle from being crashed' (K. Kamiya, 2004) -- SLP

○'How to fix the string left shorter than the needle at the end of sewing' (T. Shimoda, 2006)
-- whole process of problem solving with USIT.

-- 'How to prevent shoplifting at a bookstore' (N. Hayashi, 2006) -- Time Analysis

●'TRIZ Home Page for Students by Students' (M. Hida, 2006)

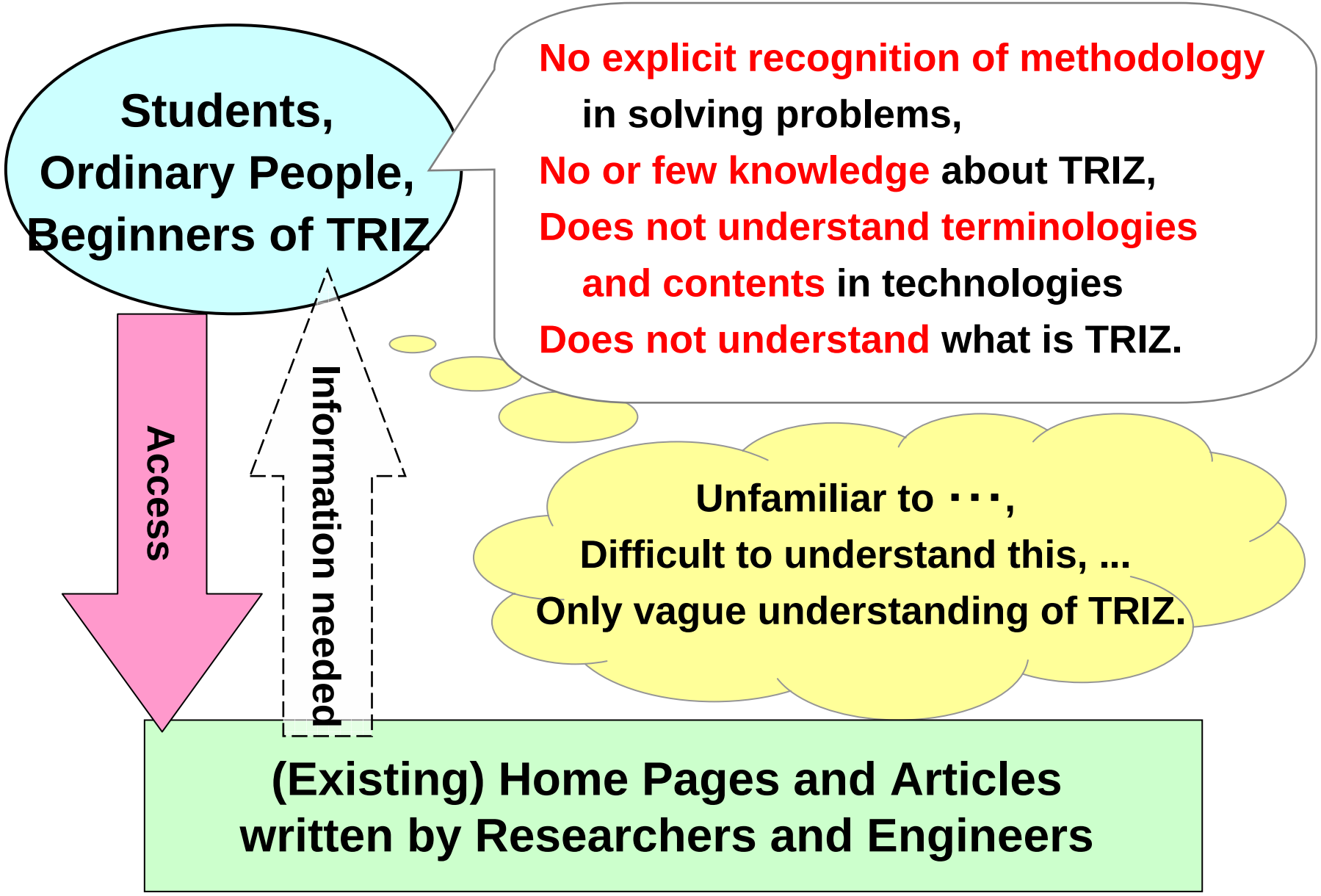
○'How to prevent unauthorized persons from entering the auto-locking door of apartment building' (A. Fujita, 2007) -- TRIZ/USIT to a social & technical problem

○'How to prevent cords and cables from getting entangled' (T. Itoh, 2007)
-- Classify the solutions.

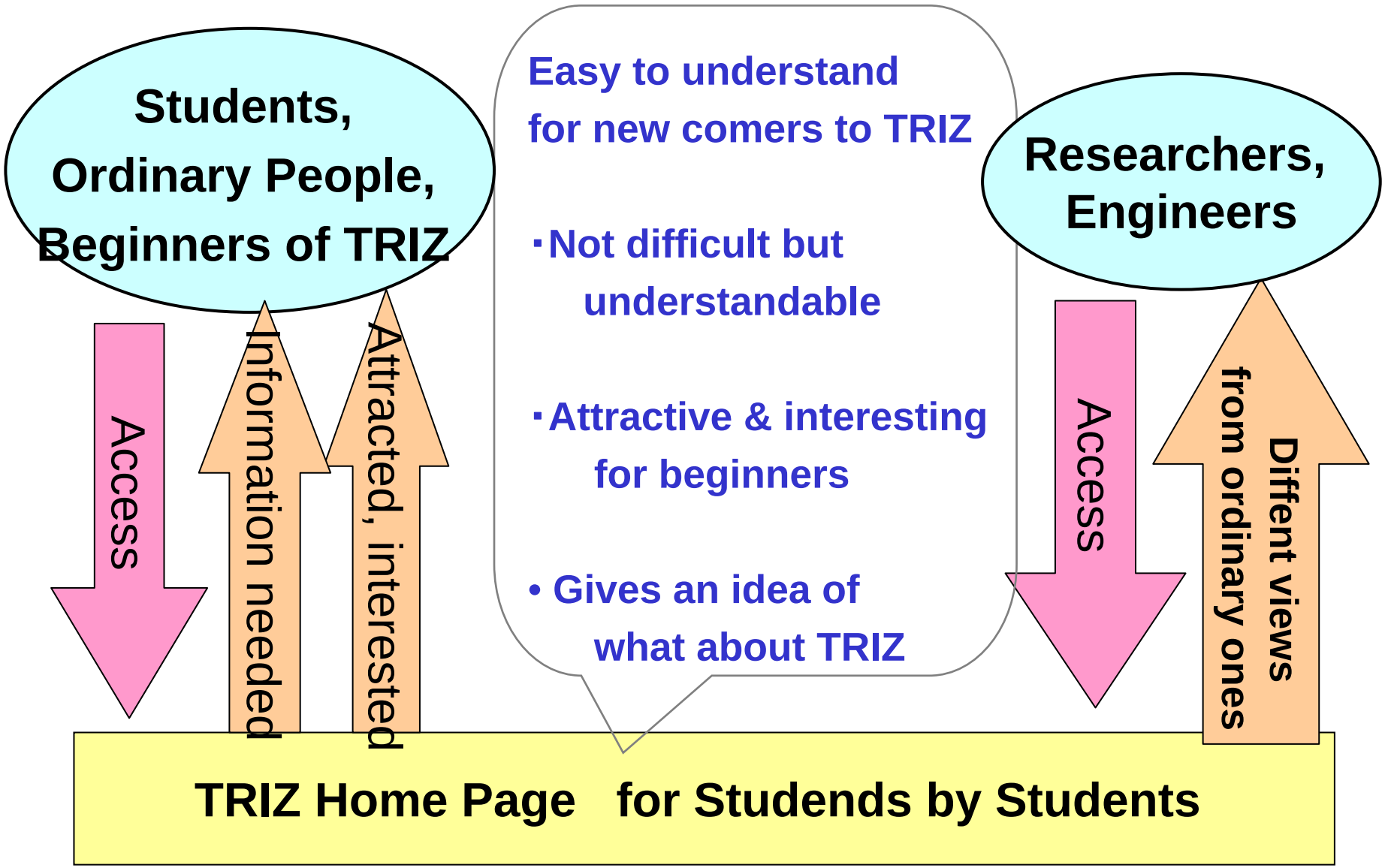
●'How to help recall passwords' (Y. Ueda, 2009) -- Physical contradiction in human thinking.

○'Methods and Tools for Removing Weeds' (T. Miyake, 2011) -- Systematic understanding

Needs for a TRIZ Home Page for Students



Aims of a TRIZ Home Page for Students



3.3 Solving Familiar Problems:

T. Shimoda and T. Nakagawa (2006)

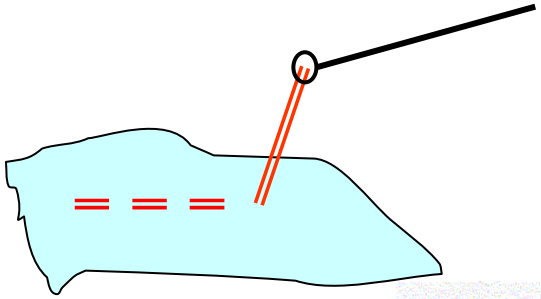
How to fix a string shorter than the needle at the end of sewing

Problem Definition:

(a) Undesirable effect: The string is shorter than the needle and prohibit applying the standard way of making a knot.

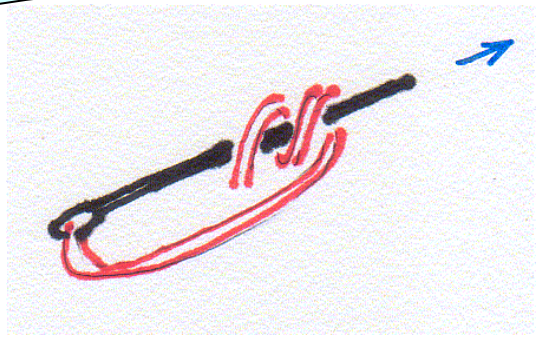
(b) Task statement: Devise methods for fixing the string left shorter than the needle.

(c) Sketch:



(d) Plausible root causes:

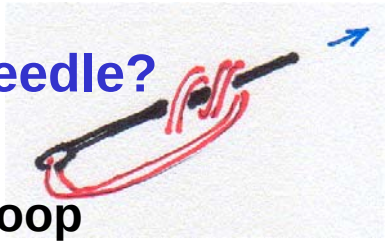
The standard way of making a knot is applicable only when the string left is longer than the needle.



(e) Minimum set of relevant objects:

Cloths, string (already sewn), string (left), the needle

Problem Analysis (1): Understanding the present system



(1) Functional analysis: What is the function of the Needle?

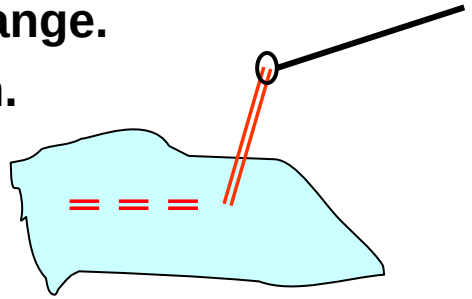
A base for making a loop of the string;

A guide for passing the end of the string through the loop

(2) Attribute analysis: Properties taken for granted form the Constraints:

The string does not expand = Its length does not change.

The needle is hard = No change in shape and length.



When any of these constraints is lifted,
there appears a novel solution.

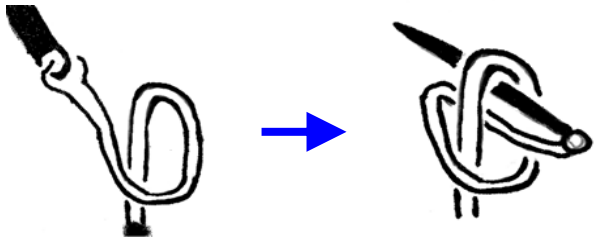
(3) Analysis of time characteristics: Processes of sewing:

Solutions at the final stage and solutions at any earlier stage.

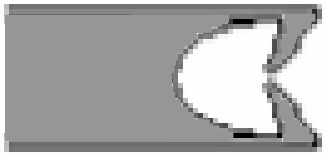
(4) Analysis of space characteristics: A knot makes the string thick at the end.

Watch out about the topology in making a knot and in the 'hole and string' .

Several known solutions:



A well-known technique.
Difficult to make the loop of string in the space; need some practices



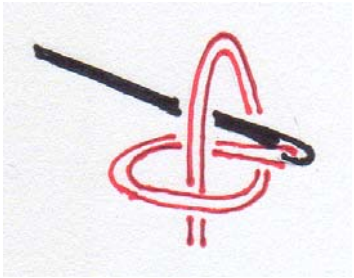
The hole of the needle has a slit, thus the string can be passed and removed without cutting the loop of the string. (a commercial product)

Problem Analysis (2) : Understanding the Ideal system

Ideal arrangement of a sting in space for making a knot

It should be nice if we could hold the string in this arrangement in the space.

Solution Generation:
Generate Ideas and Construct Solutions



Known technique

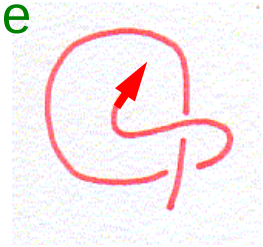
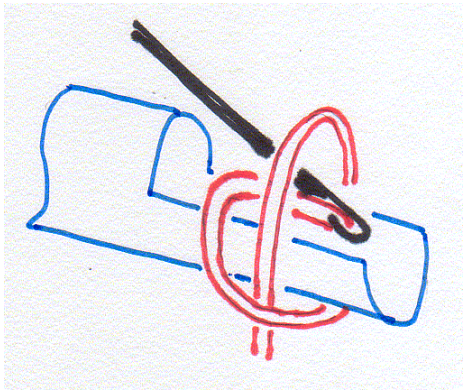
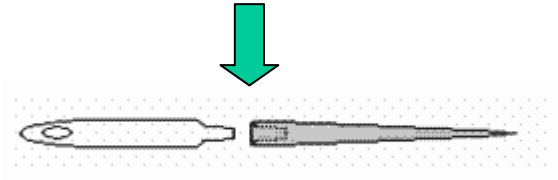


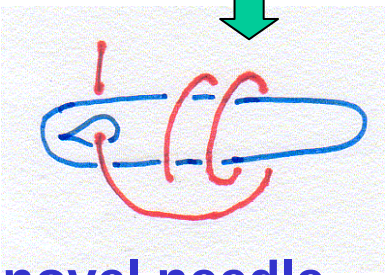
Image of
Ideal situation



A novel tool made of a straw

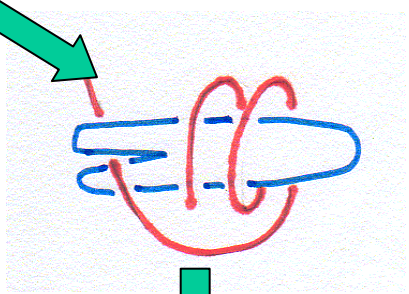
A ridiculous idea : 'Break the needle!!'



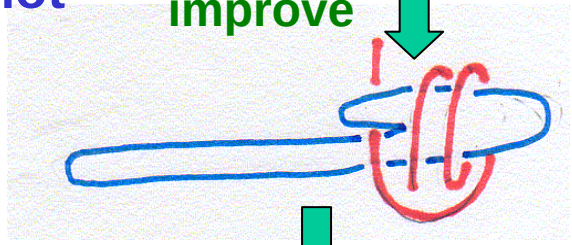


A novel needle specialized for making a knot

improve



improve



improve

3.4 Seminar IB (1st year):
Learning "7 Habits of Highly Effective Teens" by Sean Covey

Started with ″7 Habits″ book since 2008.

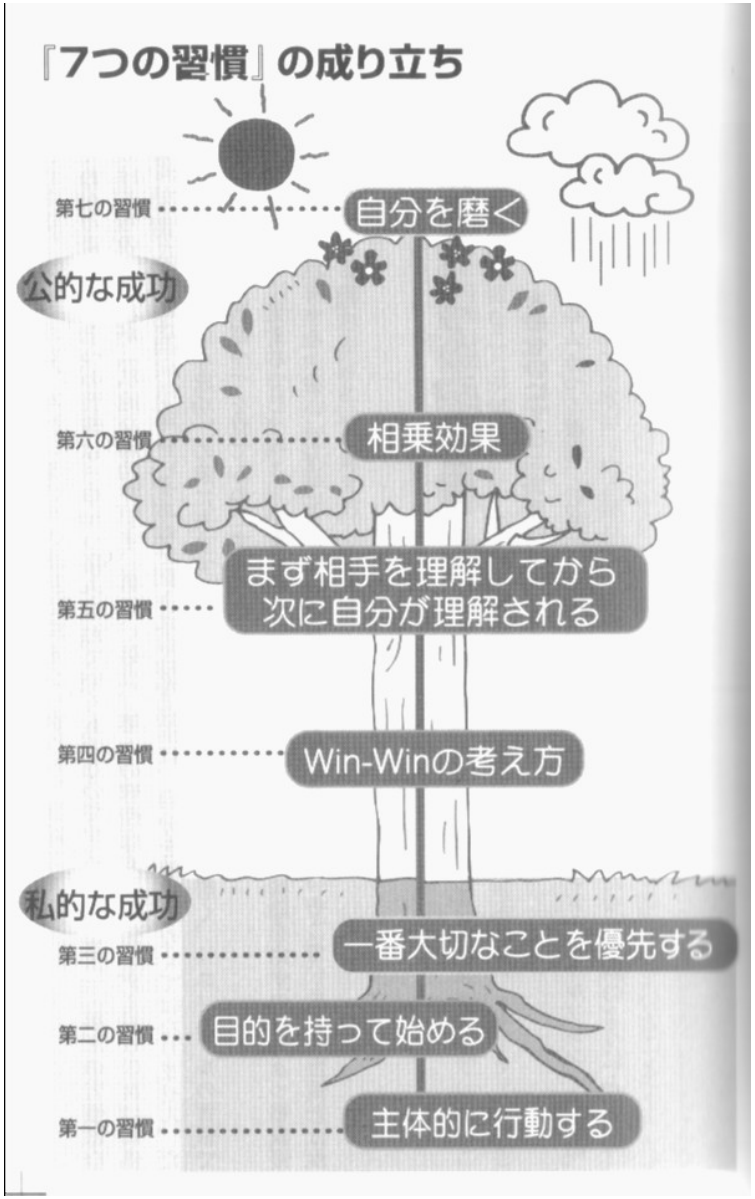
Reading the text by turn and discuss.

Must submit Reports 3 (or 4) times
on ″What I learned and what I thought″
not just ″What I read and what I feel″.

Teacher revises the expressions and writes comments, and feeds back a collection of students reports to all the class

I posted students' reports and my comments in ″TRIZ Home Page in Japan″.

Establishing independent mind is necessary before learning creativity



3.5 "Toru Nakagawa's Mission Statement"
-- A homework submitted by a teacher

The book advises to write your own Mission Statement.
'the image what I want to be', 'my motto' in any style

I wrote my own Mission Statement, only after year and half.

Toru Nakagawa's Mission Statement

1. Be sincere and serious.
2. Move the ego out of the way,
   and have the open, warm heart.
3. Take care of the health and have a positive mind.
4. Think flexibly and creatively.
5. Serve for people and society.

Dec. 14, 2009 Toru Nakagawa

3.6 "How to Build & Write a Report (Paper)"

Taught in the Class.

Pubished in "OGU Communications"
and in "TRIZ Home Page in Japan"
(2002 and 2010)

Part 1: Purpose, preparation,
structure, contents,
remarks, etc.
in top-down descripton

Part 2: Writing expressions
in bottom-up descrition

Part 3: One-sheet summary
See the right figure.

レポートの作り方・書き方

2010. 7.15

大阪学院大学 情報学部 中川 徹

レポートを作る

レポートの目的を明確にする

感想文ではない。
報告書、論文、提案書、など
誰に読んでもらうのか

締切は?
自分が利用可能な時間は?

課題の範囲、
中心テーマはなにか

中身を作る 調査・実験・研究

中身がなければ、何も書けない。

・課題の範囲、状況の概要を明らかに
・観点を明確に
・予備知識を得る(本・インターネット)

・実地に調査する
・実地に実験する
・文献・資料を調査する

・結果を整理する
・考察する
・結論・ポイントをまとめる

執筆の準備と執筆活動

調査・実験・研究のノート

内容のポイントをメモ書き
基本的な構成(アウトライン)

基本資料の原稿を作る
(集計記録、分析のグラフ、図など)
文献のリスト

本文を執筆する(書式に沿って頭から)

書いたものを、繰り返し推敲する

レポートの構成

レポートの形式

表紙部分
・提出先・提出日
・表題 -- 内容を簡潔に表す
・著者(共著者)・所属

概要(Abstract): 本文を読まないで、内容のエッセンスが分かるように

序論: 文書の目的、課題の導入、何が問題なのか

本論

結論(Conclusion):
本文を読んだ読者に対する簡潔なまとめ、提言

参考文献

調査/実験結果の報告

調査の目的(序論)

調査の方法
調査の結果
調査の分析
調査結果の解釈と考察

結論 (明確になった事実、提言など)

概念/技術の調査報告

調査の目的(序論)

調査の対象
調査結果の内容(各事例)
調査対象の吟味(従来のものとの比較、考察)

結論 (明確になった事実、提言など)

新しい技術・方法などの提案

問題意識(序論)

従来の技術や方法
その問題点と解決すべき課題
新しい技術・方法の提案
(基本的な構成法、根拠や原理)
新しい技術・方法の実験結果、実施例
新しい技術・方法の効果
考察・検討

結論 (提案の骨子と提言)

文章の書き方

指針: 中身の情報を正しく、速く読者に伝える

事実に基づいて
論理的に
一貫性
きちんとした構成
明快

簡潔に
読みやすい
分かりやすい
ぱっと見て分かる
要点を最初に

語句のレベル

標準的で分かりやすい表記法
簡潔で、明快な表現

文のレベル

文を簡潔、適切に区切る。
一つの文に多くを盛りこまない。
修飾語を修飾先に近く置く
事実と意見/考えを区別する

文の繋がりのレベル

文と文を接続詞で論理的に繋ぐ
重要なことを先に述べ、後で説明
視点の変化は明記する

段落のレベル

数行で一つの段落に
段落は、内容的なひとまとまりの文章
段落の先頭に主文
その後に、説明、例示、詳細化など

節や章のレベル

段落を単位として、階層的に構成する
見出しをつける

文書全体のレベル

中身を表すようにタイトルをつける
文書全体の構成をきちんと作る

4. Social promotion:

Presentations, Trainings, Home Page, Academic society, etc.

- Presentations and giving lectures at conferences in Japan
- Presentations at international TRIZ conferences:
  TRIZCONs (USA) and ETRIA TFC (Europe)

- Publishing Japanese editions of TRIZ textbooks (in teams)
- Posting Japanese translation of seleced overseas papers,
- Participation reports ('Personal Reports') of international TRIZ conferences

- USIT Training Seminars

- Public Web site "TRIZ Home Page in Japan": Editor, operation, writing

- Japan TRIZ Society, NPO; Holding Japan TRIZ Symposium (annually)

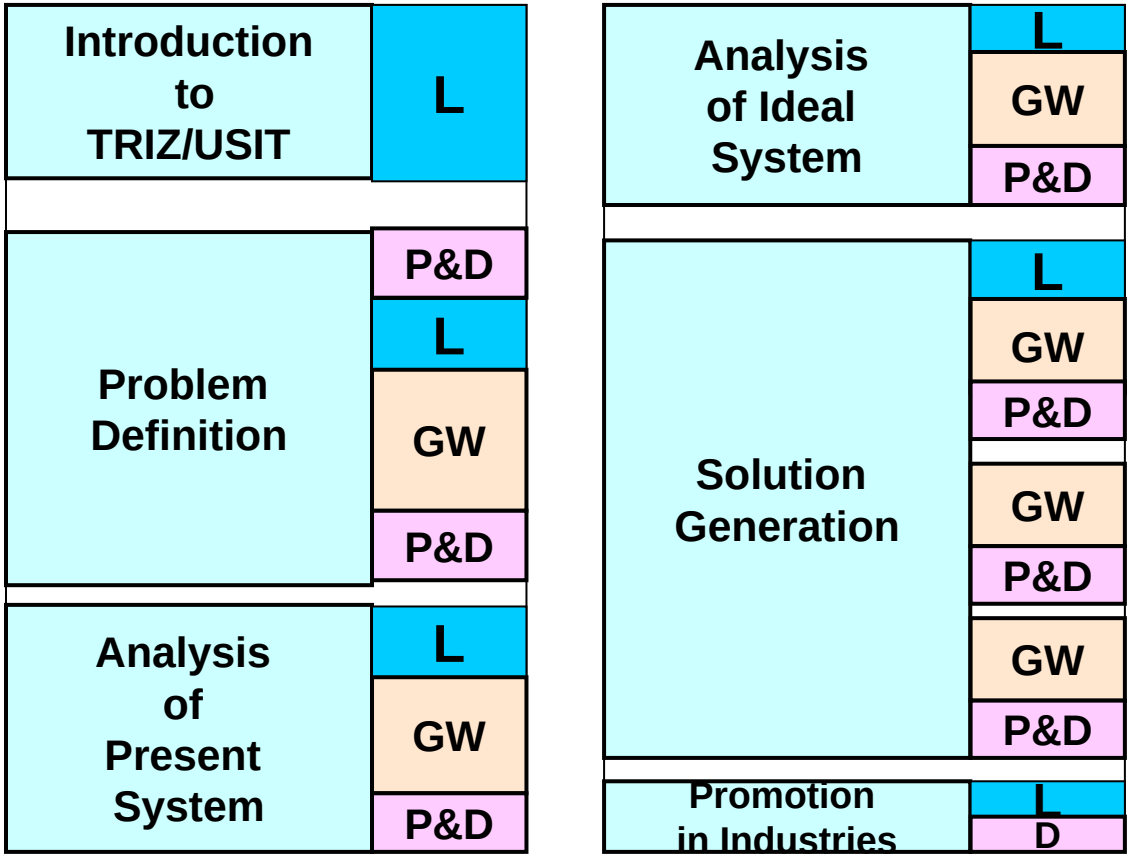
4.2 Training: In-company and open USIT Trainings

- USIT is much easier to learn than (conventional) TRIZ.
- USIT fits well for group work.
- USIT is applicable to real problems for conceptual solutions.
- Use TRIZ knowledge base tools in a complementary way.

2-Day USIT Training Seminar

3 real, brought-in problems are solved in parallel in the group work

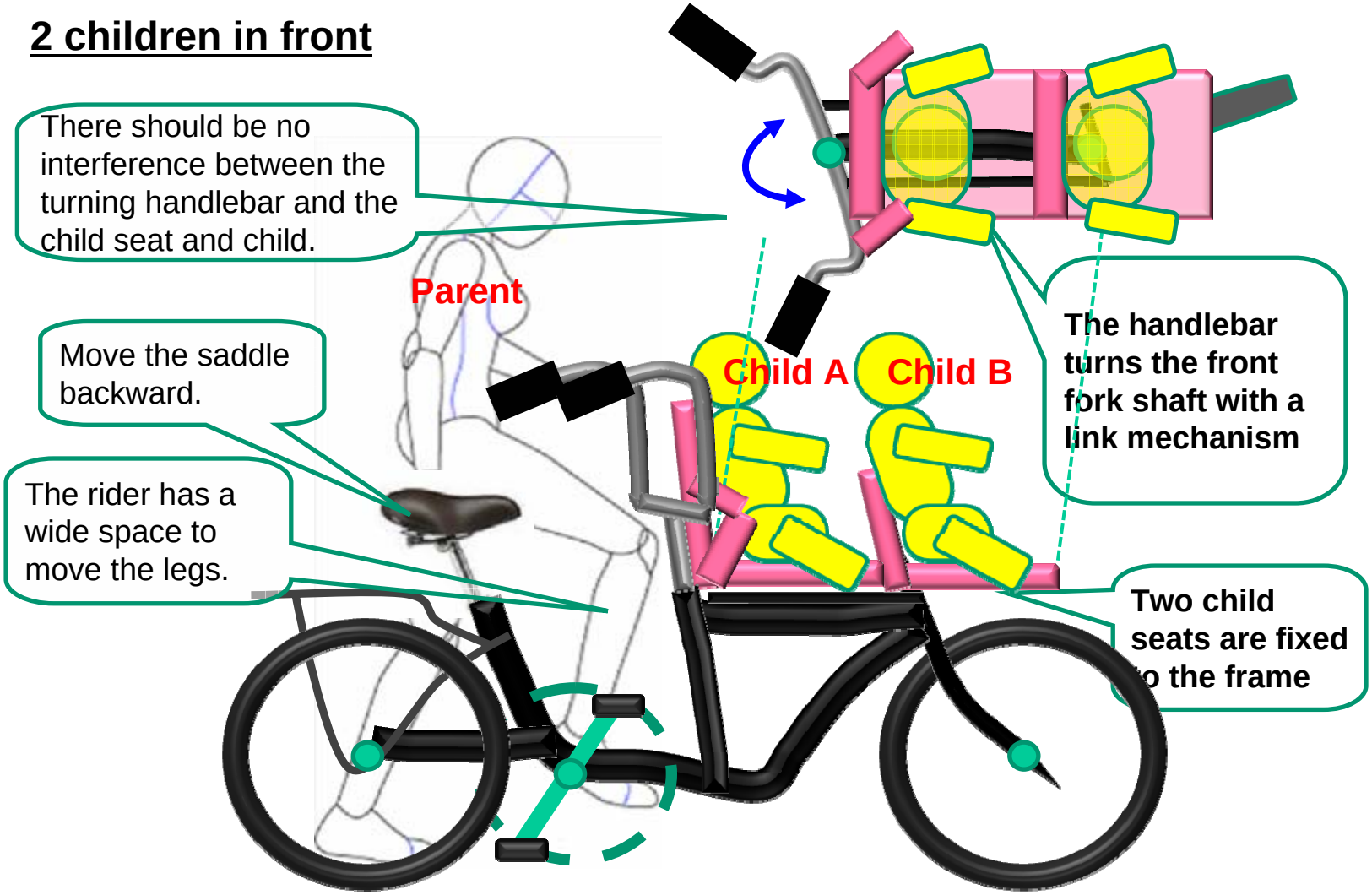
L	Lecture
GW	Group work
P&D	Presentation & Discussion



'A Mom's Bicycle for Safely Carrying 2 Children'

Result of a 2-Day USIT Training Seminar

2 children in front



Essence: Fix the front child seats to the main frame.
1 in the front, 1 at the back is also possible.

4.4 Organizing Japan TRIZ Society (NPO) and Holding TRIZ Symposium in Japan

TRIZ Symposium in Japan (Annually, 2005 -)

Organized by Japan TRIZ CB and
later (since 2008) by Japan TRIZ Society

TRIZ シンポジウム 2005
The First TRIZ Symposium in Japan

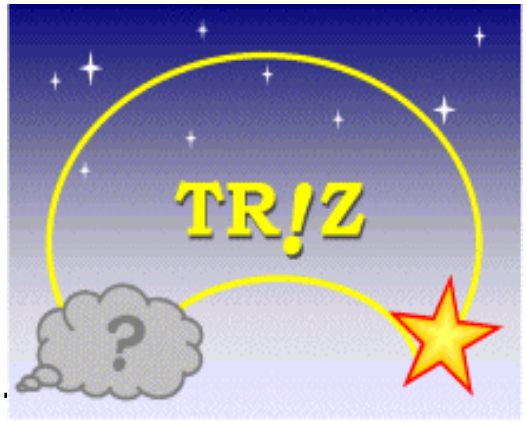
Japanese National AND (partially but as much as possible) International
- Slides are projected in two languages (Japanese and English) in parallel.

Well-organized public/academic conference
- Presentations and attendance by many industrial people
- Active and friendly presentations and discussions

Year		2005	2006	2007	2008	2009	2010	2011
Presentations	total	21	35	37	46	43	40	40
	overseas	(3)	(11)	(11)	(13)	(14)	(13)	(9)
Attendees	total	104	157	201	180	137	165	115
	overseas	(4)	(18)	(10)	(15)	(19)	(46)	(11)

4.3 Web site "TRIZ Home Page in Japan" and the vision of 'Global Network of Public Web Sites'

"TRIZ Home Page in Japan" Web site
in Japanese and in English
Established since Nov. 1, 1998
Editor: Toru Nakagawa



An open forum for better understanding and usage of TRIZ.

Posting introductory articles, papers, case studies, news, communications, etc.

All my works are posted here.

Articles written by many different authors in Japan and overseas are posted.

Japanese paes and English pages in parallel as much as possible.

All the articles accumulated for 13 years can be accessed with one click from the categorized general index.

Updated irregularly, every 2 to 4 weeks. 1 to 5 articles ever time.

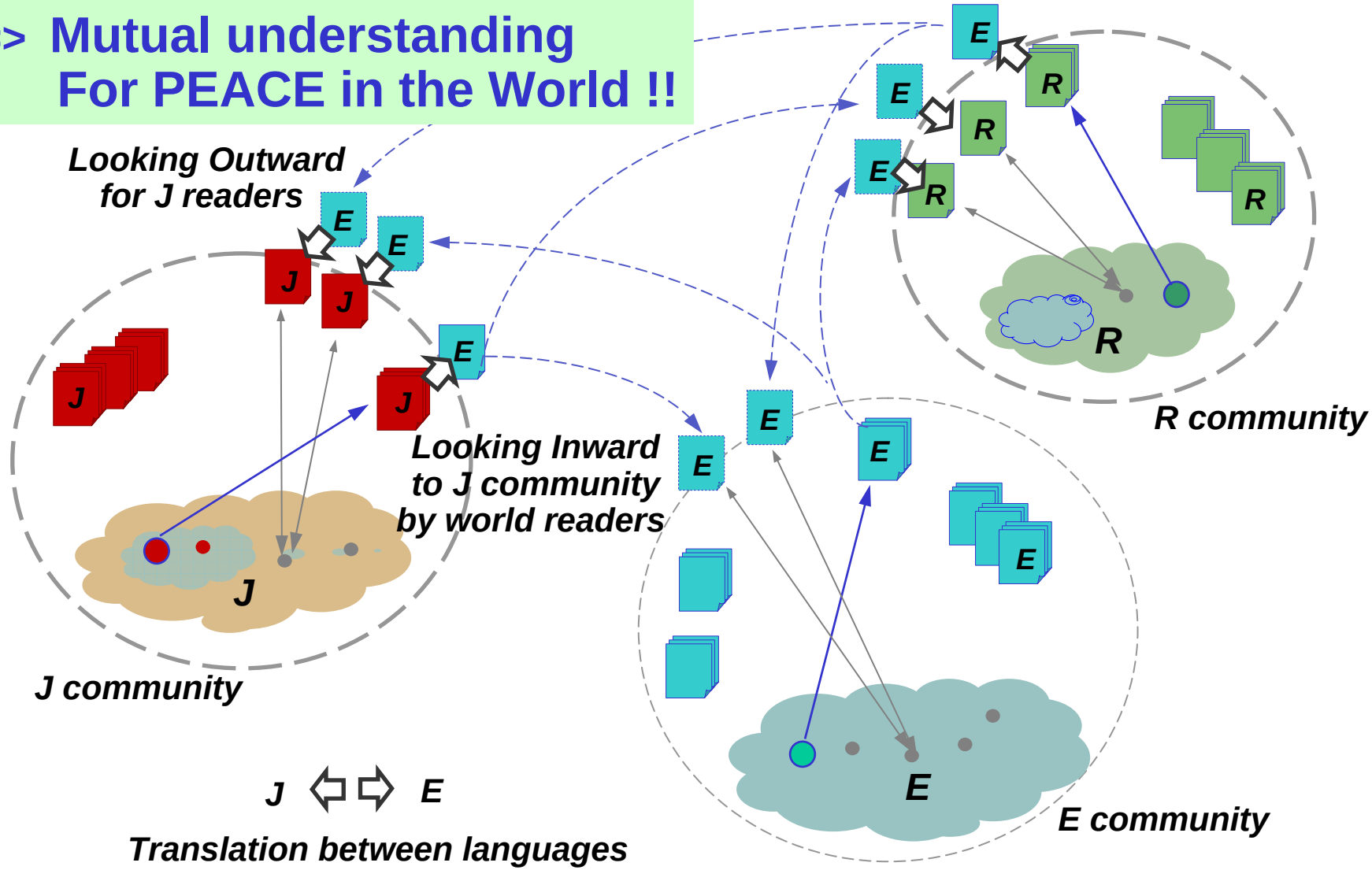
Update Annuoncement is sent via email to ～700 in Japan and ～400 oveseas.

==> A model of "Public Web site".

Global Network of (Regional) Public Web Sites in TRIZ

==> Autonomous growth of Global TRIZ Community by overcoming language barriers

==> Mutual understanding For PEACE in the World !!



I wish to express my sincere thanks
to you and many others
who have been supporting me for many years.

I will continue my activities related to
"TRIZ Home Page in Japan"
as long as my health allows me.

I wish all the best
to Osaka Gakuin University, to Faculty of Informatics,
and to all of you !!

Toru Nakagawa
Email: nakagawa@ogu.ac.jp (continue)