ARIZ 85-C and OTSM Contradiction Technology

Introduction

Nikolai Khomenko
Insight Technologies Lab, Canada.
Contact: nikolai.khomenko@gmail.com

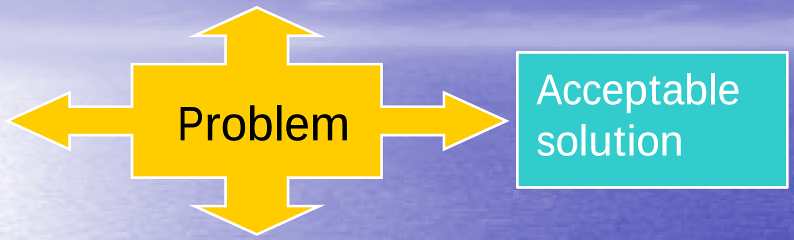
At least 80 hours training is required before apply ARIZ for solving real life problem....

G. Altshuller

What is ARIZ main production process (MPP) and main function (MF)?

What make OTSM-TRIZ instruments efficient?

Typical stereotype on problem solving:
Generate as many ideas in different direction!!!



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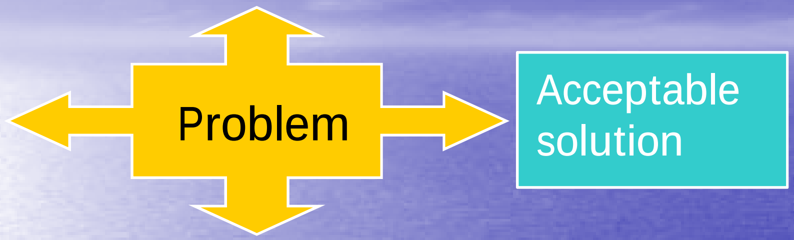
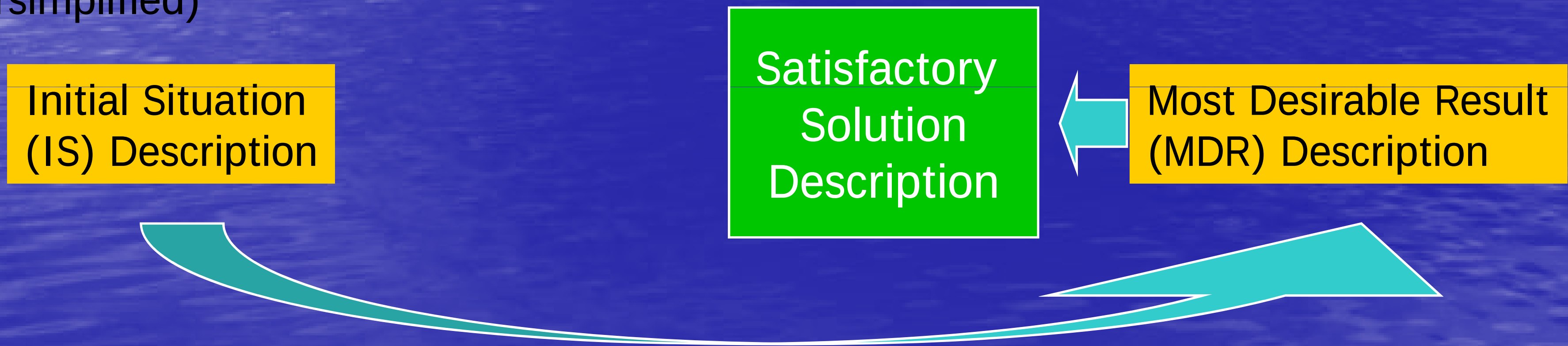
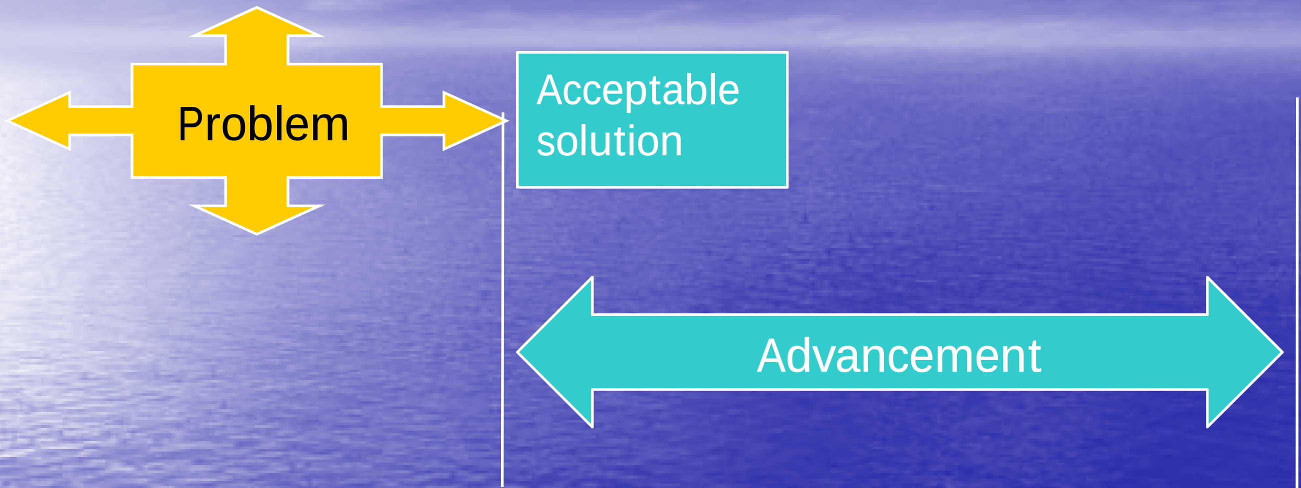


OTSM-TRIZ Problem solving process: (oversimplified)



What make OTSM-TRIZ instruments efficient?

Typical stereotype on problem solving:
Generate as many ideas in different direction!!!



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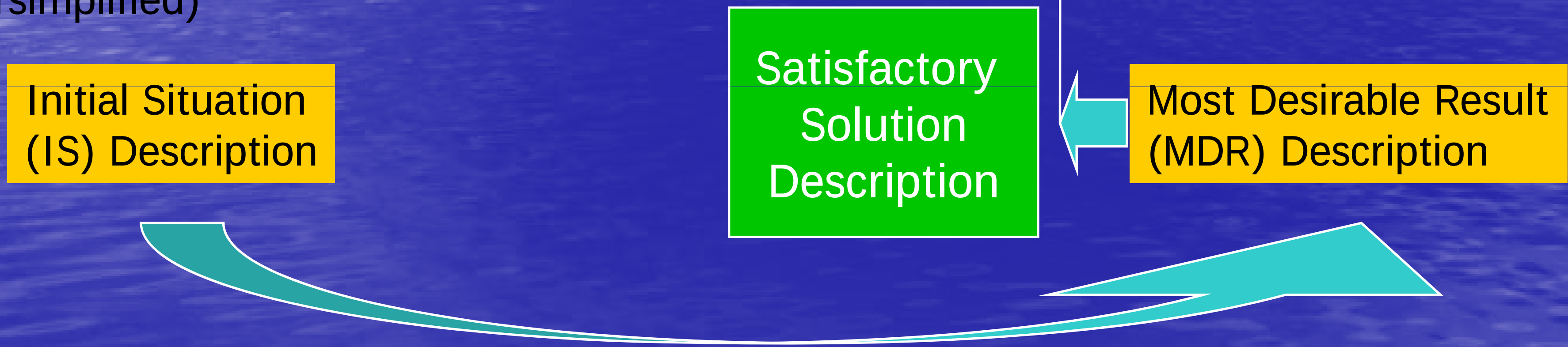
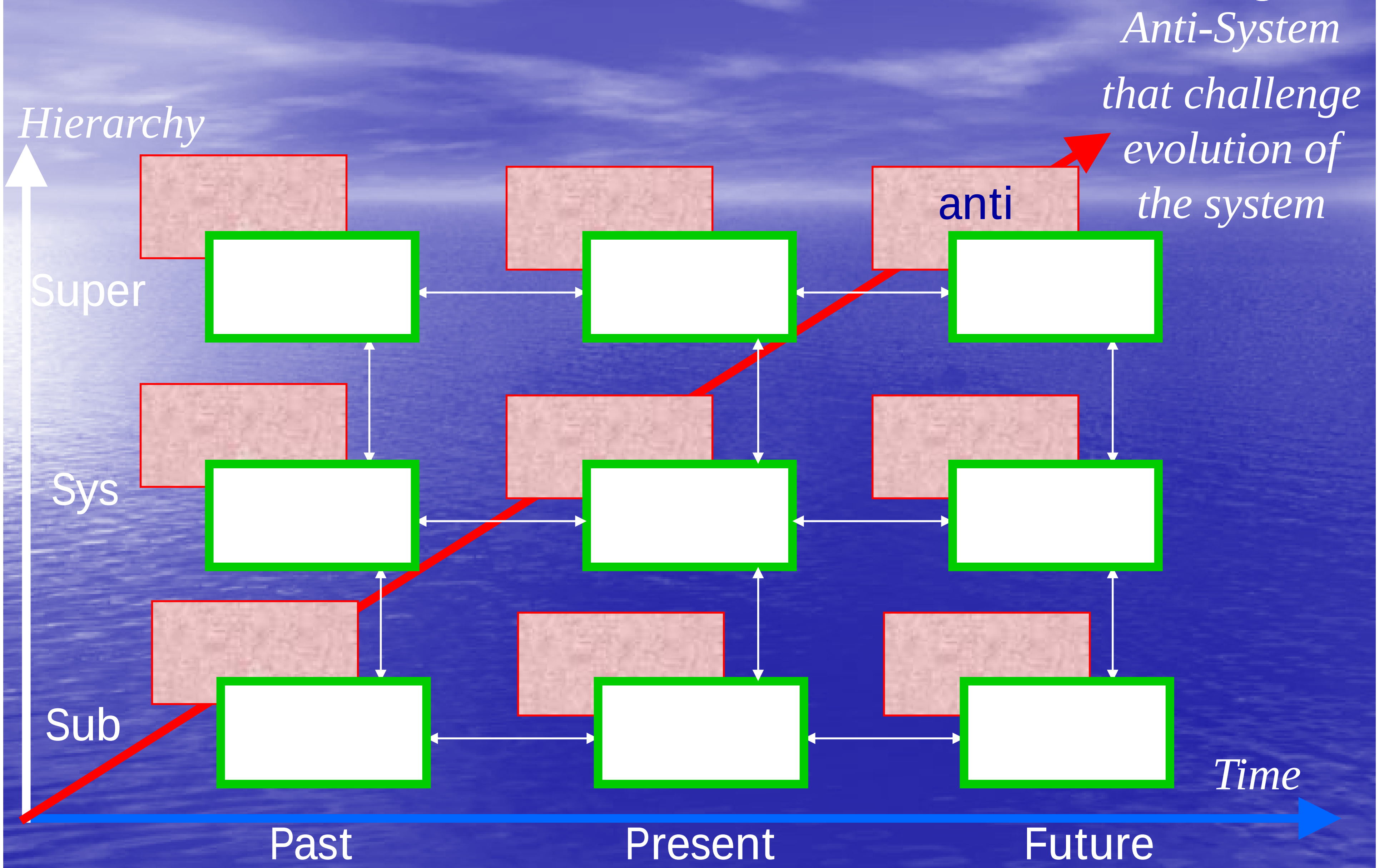


OTSM FRACTAL MODEL OF A PROBLEM SOLVING PROCESS

ARIZ is a multi-screen schema of powerful thinking presented as a line....

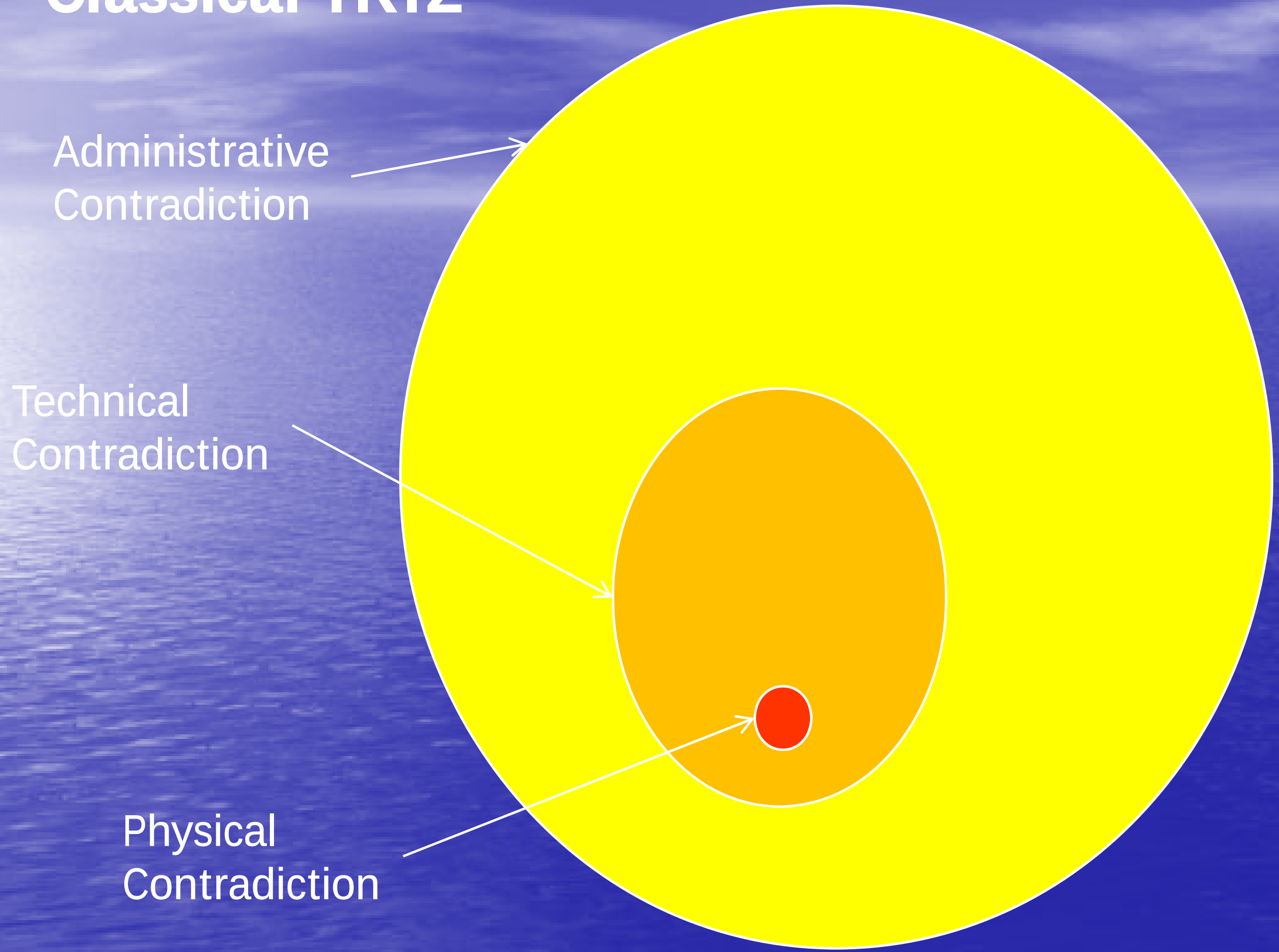
G. Altshuller

Classical TRIZ Schema of Powerful Thinking

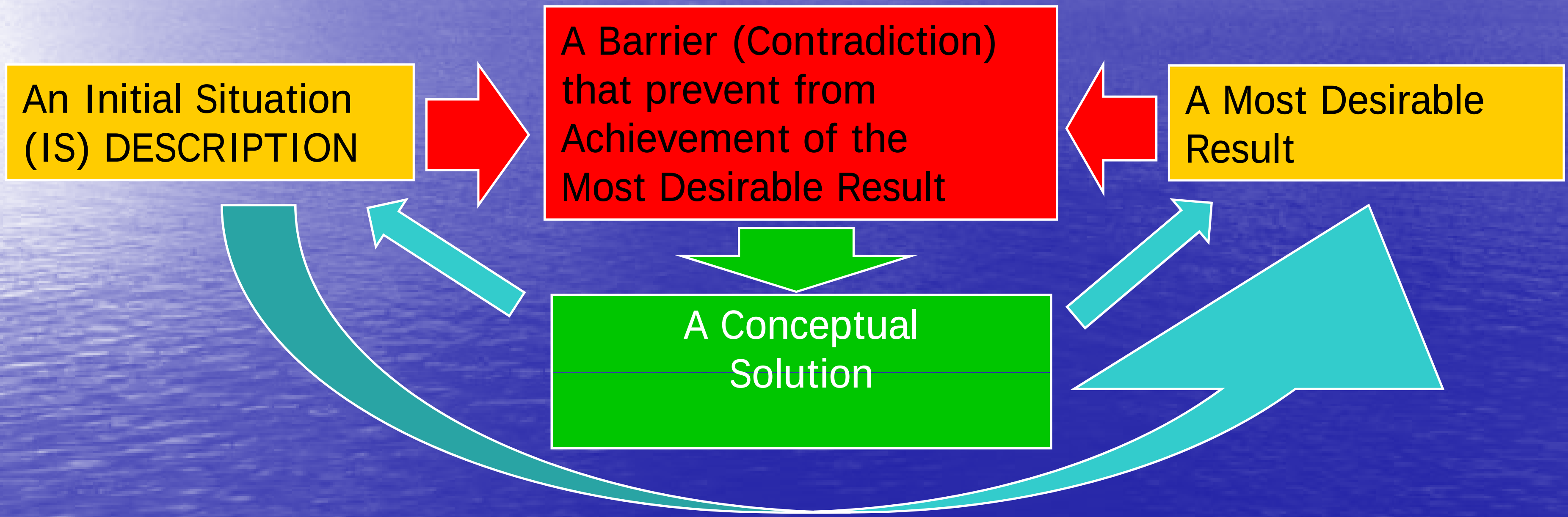


Discover the core of the problem

Classical TRIZ

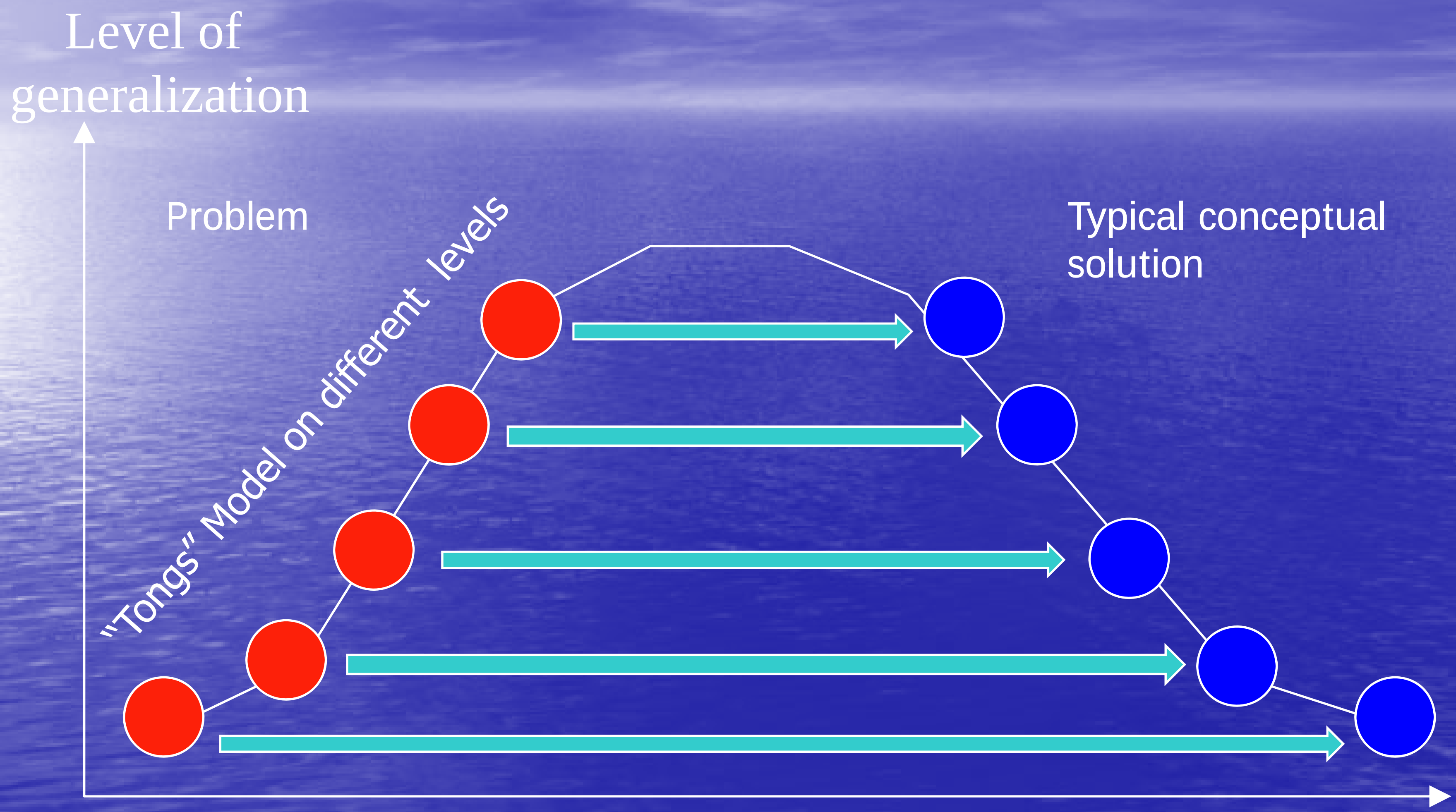


Classical TRIZ Problem Solving Process: “Tongs” Model



Classical TRIZ problem solving process:"Hill" model

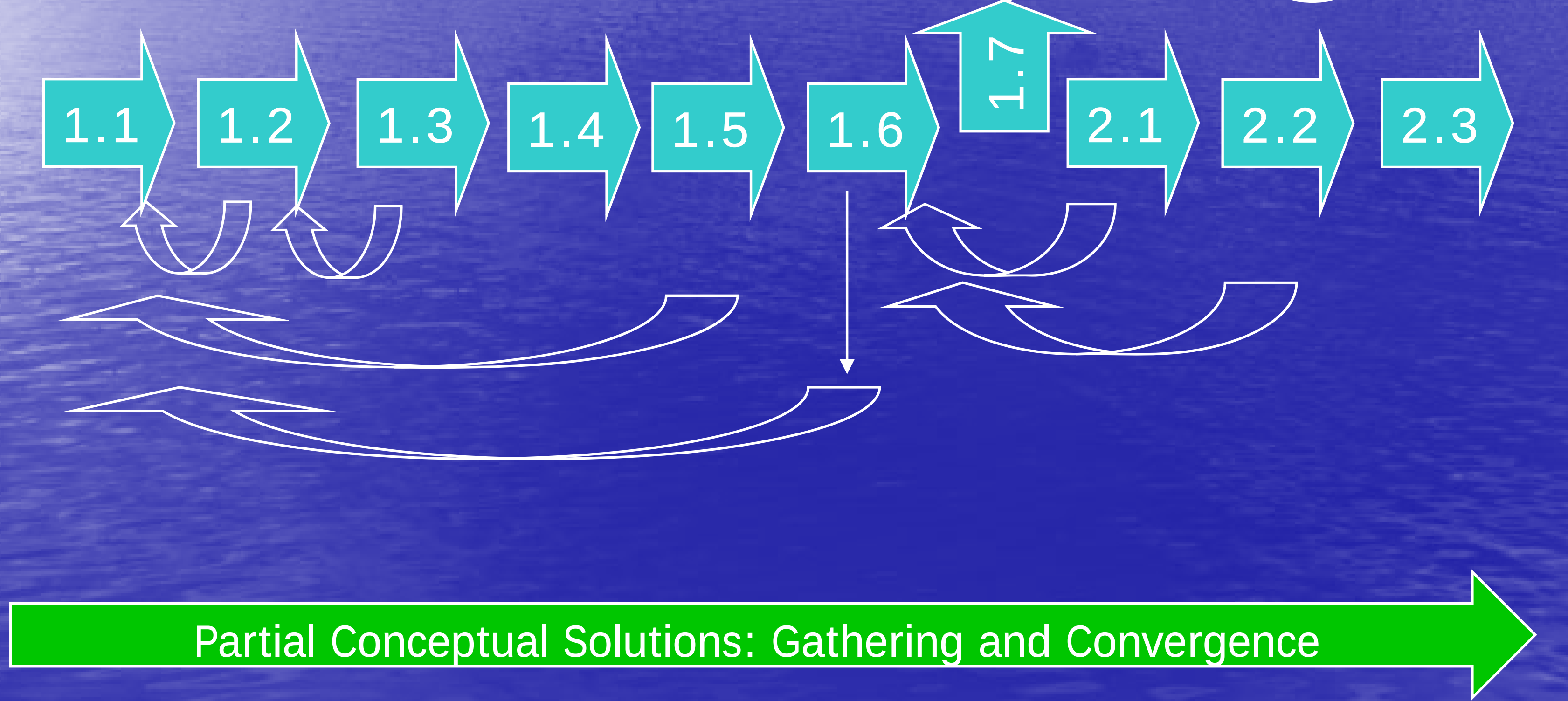
(This model was in use before ARIZ-85-C)



Classical TRIZ Problem Solving Process: Parallel Model

(Classical TRIZ problem solving Model since ARIZ-85-C)

Parts 1 and 2 of ARIZ
have liner structure with cycles.
(*Just most common cycles are shown*)



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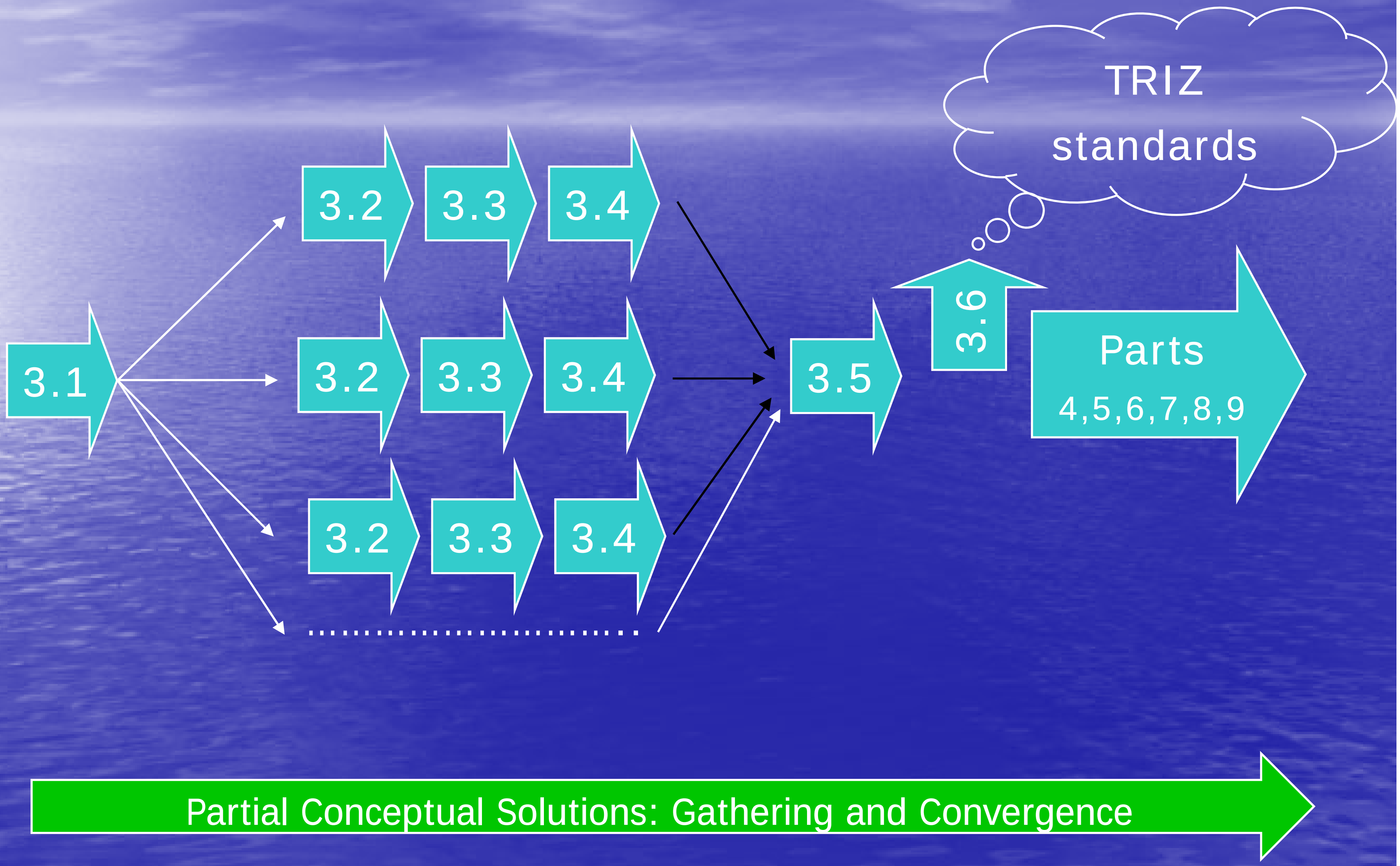
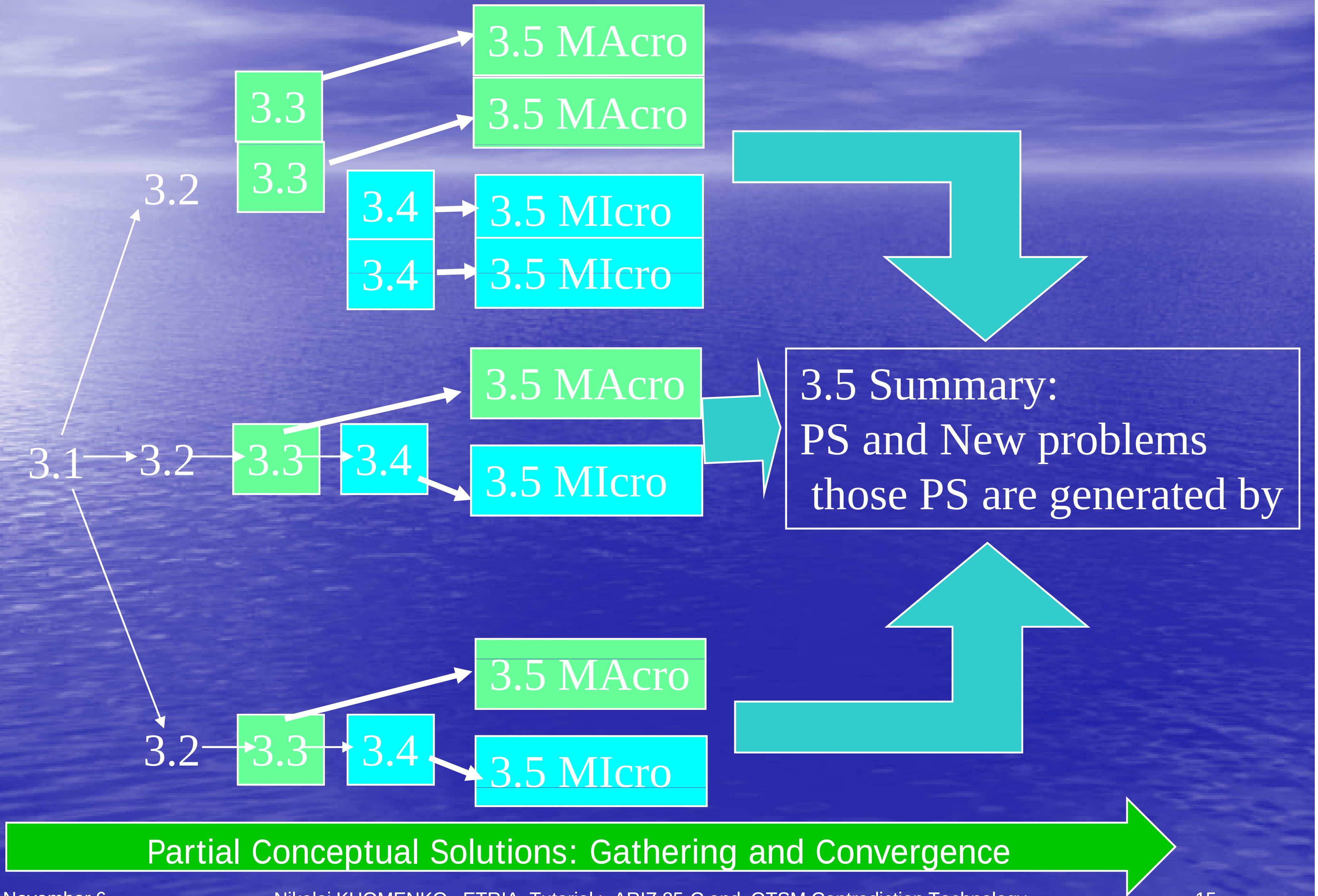
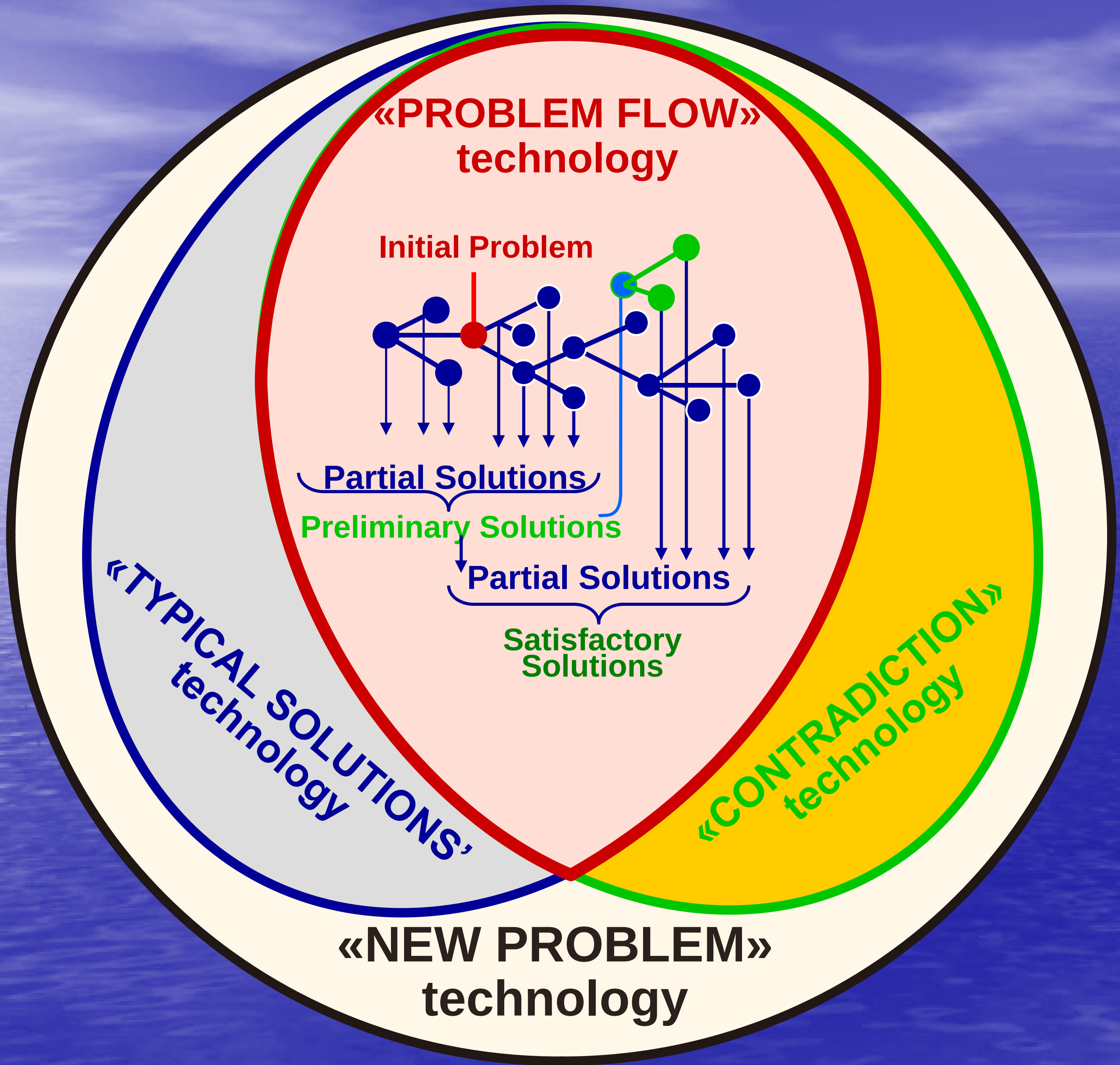
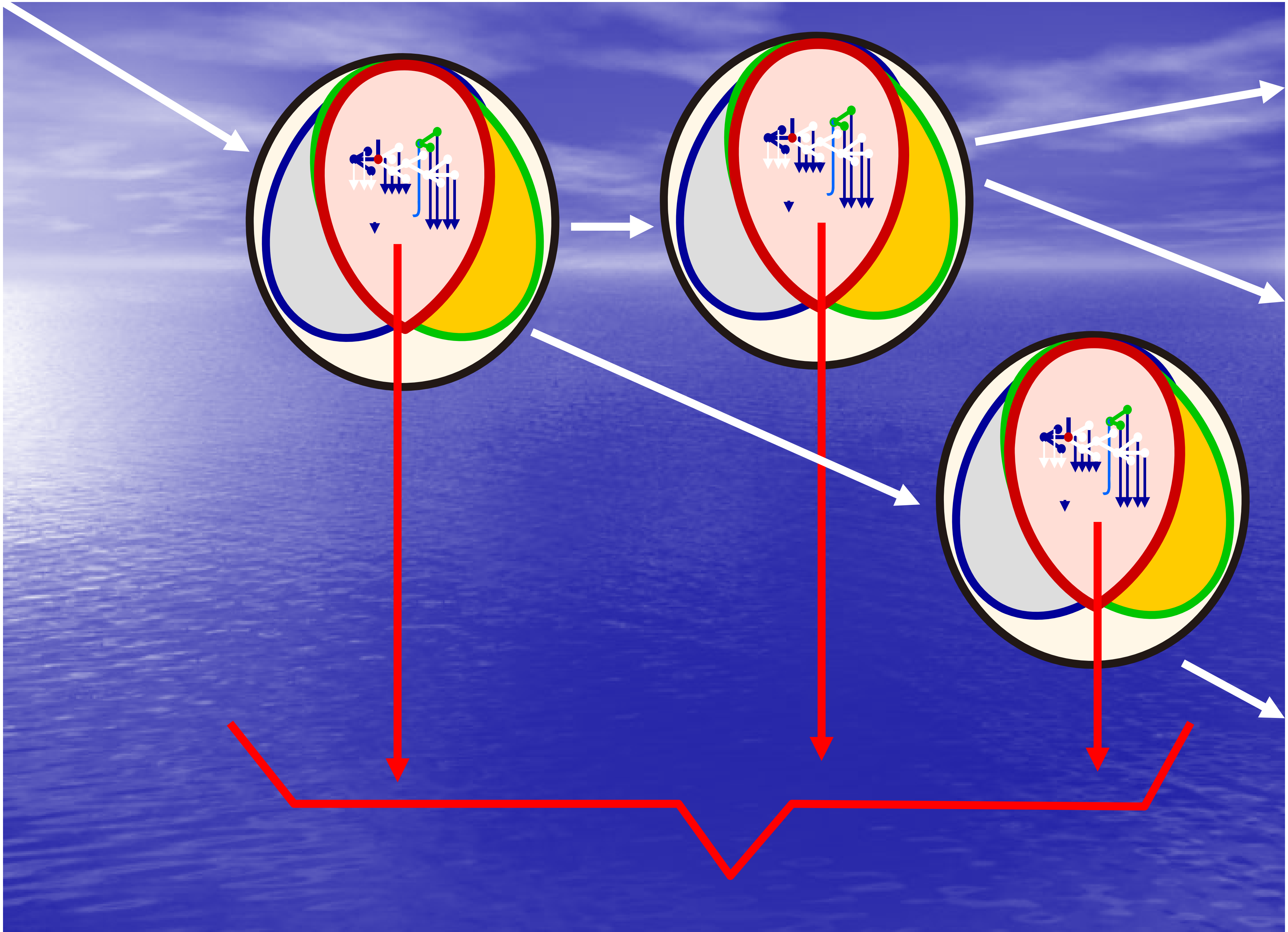


Classical TRIZ Problem Solving Process: Parallel Model (zoom in)

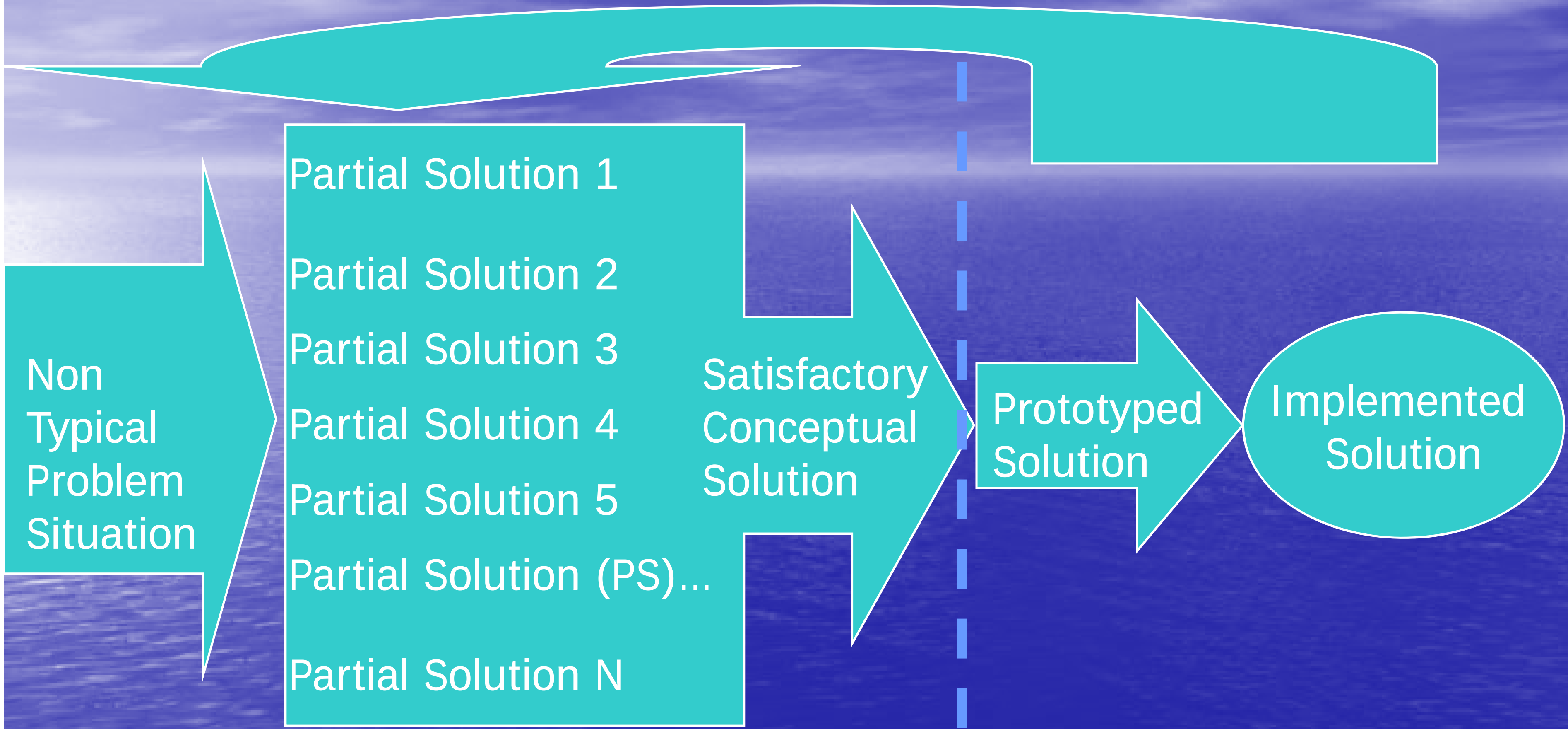
(Classical TRIZ problem solving Model since ARIZ-85-C)




«PROBLEM FLOW»
technology
Initial Problem
Partial Solutions
Preliminary Solutions
Partial Solutions
Satisfactory
Solutions
«TYPICAL SOLUTIONS'
technology
«CONTRADICTION»
technology
«NEW PROBLEM»
technology



OTSM problem solving process: Convergence of Partial Conceptual solutions into Satisfactory Conceptual solution

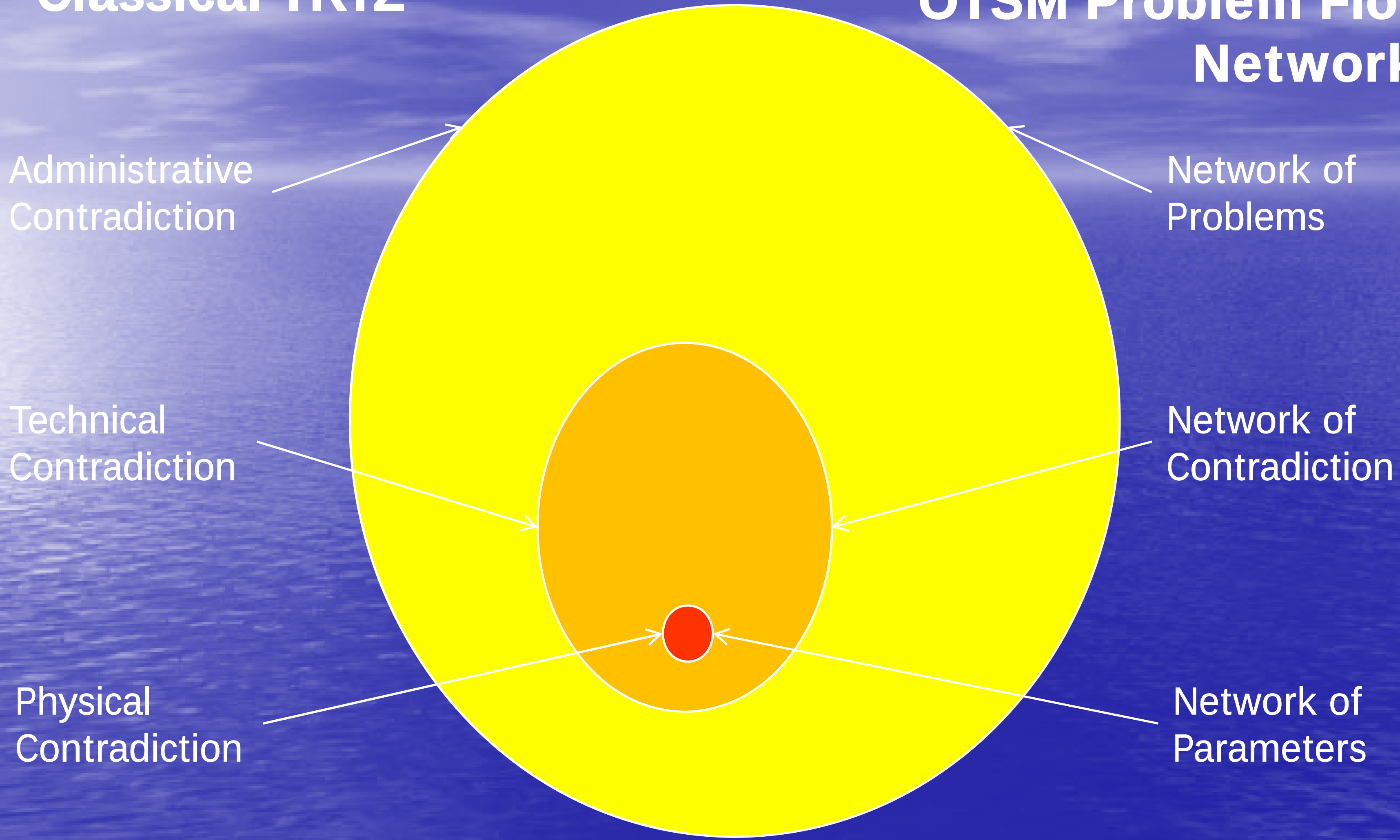


Generation of Partial Conceptual Solution based on Typical solutions
And
Convergence of the Partial Solutions into Satisfactory Conceptual Solution

Discover the core of the problem

Classical TRIZ

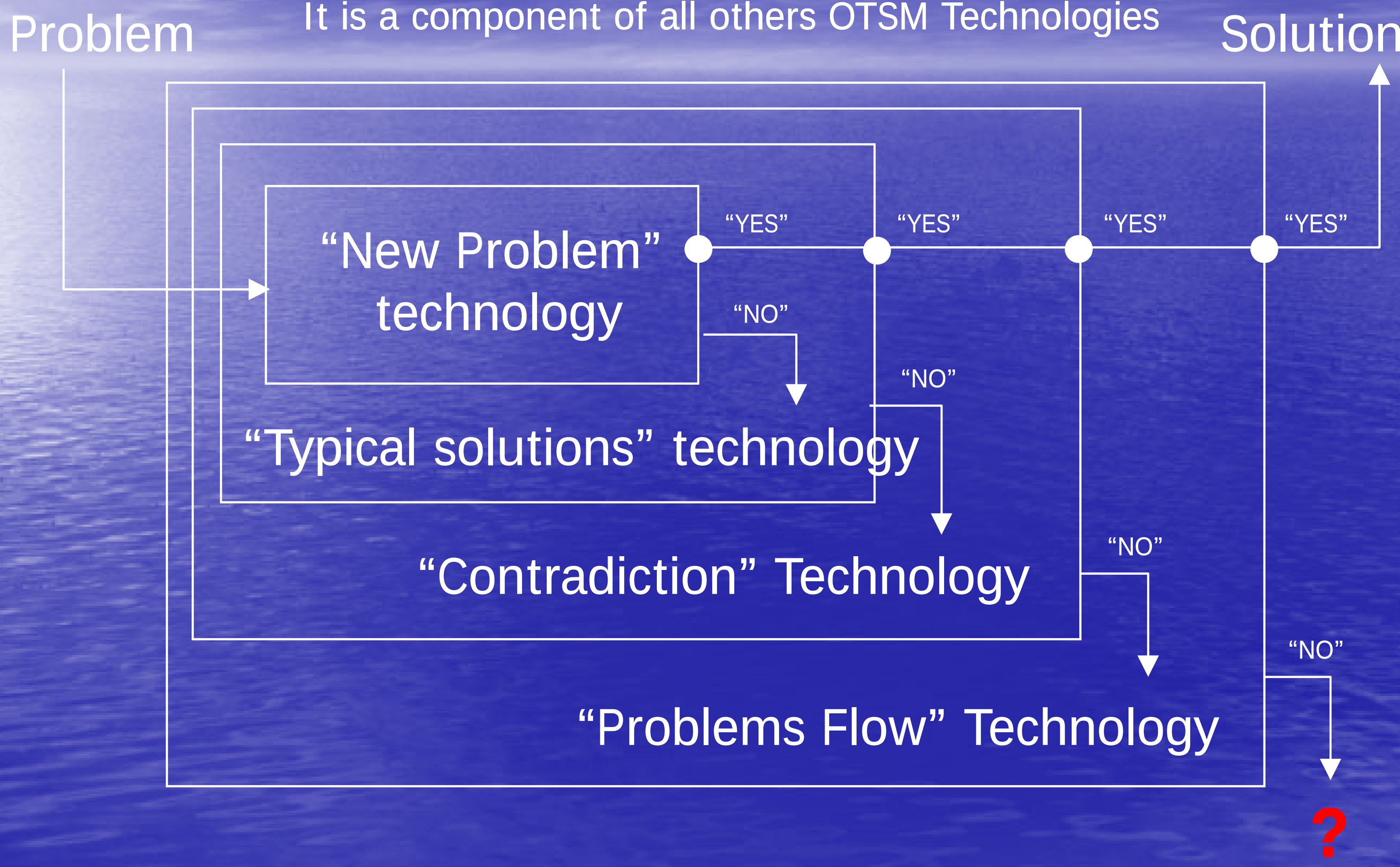
OTSM Problem Flow Networks



OTSM Problem Flow Networks approach is devoted to handle complex interdisciplinary problem situations (dozens and hundreds problems). However it work for less complex problem as well

OTSM-TRIZ technologies

Today we will focus only on most important
OTSM Contradiction Technology
which is based on Altshuller's ARIZ.
It is a component of all others OTSM Technologies



Express analysis: From Problem situation to ARIZ step 1.1.

OTSM ANALYSIS: OVERLAPPING OF POSITIVE & NEGATIVE SYSTEMS

Function (Goals) Hierarchy

Step4

- Function
- Function – Main Production Process (MPP) Level – 3 up
- Function
- Function
- Function
- Function – Level of the Function to be improved - NE
- Function
- Function

Step 3

Step 5

Step 2

Step 1

Comments:

Undesirable (Negative) Effect (NE) – Certain Evaluation Parameter has unsatisfactory Value

Step 5: analysis of deep roots of NE in sub-systems

OTSM Function Definition: 3 steps algorithm

1. Common language model of Function
2. “Verb – Noun (product)” model
3. OTSM Function Definition – “Four Verbs” model:

1. Keep 2. Change 3. Increase 4. Decrease	Value parameter - Name - Element (product)

Law of Completes: OTSM interpretation

1. OTSM ENV Function Definition – Product changes
2. Product
3. Tool
4. An Energy the Tool need to Change the Product
5. Energy Source and Flow through the system
6. Engine –last transformation of an energy for tool
7. Transmission – between engine and tool

Positive (Desirable) System versus Negative (Undesirable) System

1. Use OTSM ENV model for function description and OTSM model for Minimal Complete Engineering System in order to develop models of positive and negative systems .

2. Compare structure of Positive and Negative systems in order to discover common components between them.

3. Which component of negative system and what property of the element should be changed to stop negative system without damage for Main Production Process (MPP)? What typical solution could be used to make these changes. What new Negative events provoke this typical solution?

OTSM Diagram for problem description

Preparation for the step 1.1. ARIZ 85-C.

Summary of the express analysis of positive and negative systems.

E —— CP

V

Then values of

EP-1 is “-”

EP-2 is“+”

The Most Desirable Result (MDR)

V opposite

Then values of

EP-1 is “+”

EP-2 is “-”

CP is cross parameter for parameters EP1 and EP2

EP-1 = f1 (…….CP……)

EP-2 = f2 (….CP……..)

OTSM Diagram for problem description

System of Contradictions
for the given Specific System (SS)
(Specific way to fulfill the Function)

Contradiction of a
Control Parameter (CP):
Between two opposite
values

V

E —— CP

PC (CofCP)

V

opposite

Then values of

EP-1 is "-"

But TC-1 (CofSS-1)

EP-2 is "+"

MPP

The Most
Desirable
Result (MDR)

Then values of

EP-1 is "+"

But TC-2 (CofSS-2)

EP-2 is "-"

CP is cross parameter for
parameters EP1 and EP2

EP-1 = f1 (.......CP......)

EP-2 = f2 (....CP.........)

List of
resources
were
mentioned
here

FROM A PROBLEM TO A MODEL OF THE PROBLEM

Reflection Stage – Present the chosen Problem: Summary about previous steps (analog Altshuller's ARIZ 1.1.)

1. To fulfill <MPP> <Function> should be performed.
2. List of Elements to perform the Function:
3. Contradiction 1 of the Specific System-1 (Analog of Classical TC-1)
4. Contradiction 2 of the Specific System-2 (analog of classical TC-2)
5. It is necessary with minimum changes to achieve: <MDR= EP-1(+) & EP-2(+)>

Comment:

Check Twice that professional terminology is eliminated.

Define the Product and the Tool
(see also Altshuller's ARIZ step 1.2.)

1. Use the positive system model and OTSM Definition of the <Function> to identify the Product.
2. The Tool is an Element of the system that directly interact Product to perform the <Function>

Comment:

OTSM model of the Minimal Complete Engineering System could be useful.

Graphic models of CofSS-1 (TC1) and CofSS-2 (TC2)

(see also Altshuller's ARIZ step 1.3.)

1. This is a reflection and check point to verify one more time the choices were done during previous steps.
2. For this purpose one more alternative way is used – graphical one (table 1 of Altshuller's ARIZ could be used).
3. If at least one element appear in graphical models which not present in CofSS-1 (TC1) and CofSS-2 (TC2) or Product and Tool of positive system does not appear in the graphical models then whole previous thinking process should be reviewed.

Chose a conflict to be solved
(see also Altshuller's ARIZ step 1.4.)

1. Analyze which of two conflict lead to increase ideality of the <MPP> NOT <Function> but <MPP>!):
   increase productivity, decrease complexity etc.

2. By choosing the conflict we chose the appropriate Value of the Control Parameter of the <Element> (See OTSM Diagram Of Problem Description) to achieve <MPP>. From now just this Value will be considered.

3. Often the <Element> appear as a Tool. If it is not then double check the whole previous analysis.

4. This step is a check point for whole previous reasoning.

Intensify the chosen conflict (analog ARIZ 1.5.)

1. Apply rules of DTC operator. Not jump to the situation looks like “maximum maximorum” or “minimum minimorum”. You can miss important information.

2. Conduct mental experiments to be sure That Desirable effect (+) improved even more and Undesirable Effect (-) became even more negative.

3. Remember OTSM axiom of the Specific Situation. Consider qualitative changes of the situation according quantitative changes of the Value of the Control Parameter of the Element (Tool).

4. This is a check point to verify dependence of EP-1 and EP-2 of The chosen Control Parameter. Then we should use this intensified Value and appropriate situation it leads to.

Reflection stage - Model of the Problem (analog ARIZ 1.6.)

1. What is the Tool and the Product now?
   After intensification of the conflict (intensified Value of the Parameter of the Element (often Tool).

2. Describe clear the intensified contradiction that fit you chose of the conflict.

3. Clarify MDR for intensified Conflict:
   One Must find an X-Element (System of X-Modifications) that will KEEP intensified Positive Effect (result) and ELIMINATE Negative effect, while the <Intensified Value> of the Control Parameter of the Element (often the Tool).

4. Check the whole previous steps and look for the points where logic is broken or not clear.
5. From Now this description of the problem should be used for further analysis.

OTSM Diagram for the model of the problem

The model of the problem should be used until IFR-1 (Altshuller's ARIZ step 3.1.

E —— CP

Tool

Value best for <MPP>

Intensified values of EPs

Should be kept:

EP Positive Value

EP Negative Value

Should be eliminated or changed

Comment:
Intensification of the Value of CP of the Element (tool) Should be done in the direction of Increasing both, Positive and Negative Evaluation Parameters for MPP

Apply Typical Solutions (mostly Standards)

(see also Altshuller's ARIZ step 1.7.)

- Now problem is reformulated and Su-Field models could be easier constructed for the Tool and EP that has a Negative (Undesirable) Value.
- Some other TRIZ and Non TRIZ Typical Solutions could be applied.
- After analysis of the achieved solutions one should write down all of them and comment Positive and Negative points and come back to this analysis.
- All of those and other partial solutions should be written separately from the log of the analysis.
- It is necessary to continue the analysis even satisfactory solution seems to be achieved.

ANALYSIS OF THE MODEL

Important Comment:

Next Three steps are dedicated to analyze available recourses that could be used to resolve conflict.

System Operator (SO) should be used, as well as along the whole problem solving process.

During next 3 steps we will zoom-in to all three dimensions of Classical TRIZ and OTSM System Operator.

Analysis of the Operational Space
(see also Altshuller's ARIZ, step 2.1.)

1. This is a check point to verify whether the conflict could be resolved in Macro or Micro Spaces (OTSM classification of the ways to resolve Contradiction of the Control Parameter).
2. Check what is Positive effect that should be kept and where in space it should appear and/or kept.
3. Check what is a Negative effect that should be eliminated and where space it is appear now.
4. Identify Zone of conflict: Check in all dimensions how PE and NE overlap each other.
5. If there is no the overlapping space it is a strong message that conflict could be resolved in space on Macro-level.
6. If there is an overlapping then check is it possible to resolve conflict in space on Micro level at least partially?

Analysis of the Operational Time
(see also Altshuller's ARIZ, step 2.2.)

- This is a check point to verify whether the conflict could be resolved in Macro or Micro Time (OTSM classification of the ways to resolve Contradiction of the Control Parameter).
- Check what is Positive effect that should be kept and when in time (start – stop) it should appear and/or kept. What has happening before and after Time interval of the PE? Identify approximately duration of the interval(s).
- Check what is a Negative effect that should be eliminated and when in time (start – stop) it is appear now. What has happening before and after Time interval of the NE? Identify approximately duration of the interval(s).
- Identify Time of conflict: Check how PE and NE time intervals overlap each other. If there is no overlapping it is a strong message that problem could be solved in time on Macro level.
- For Certain Specific Situation It could be several time scales (Parachute Problem).
- Is it possible to resolve conflict in time on Micro level at least partially?

Analysis of the operational Substances and Fields Resources (SFR) (see also Altshuller's ARIZ, step ARIZ 2.3.)

- Here we should analyze and list of Substance and Fields Resources (SFR) we could operate to eliminate conflict. Later it will be used to describe Intensified Ideal Final Result.
- List must contain Substances and Fields of the:
  - Resources in the Operational Space during Operational Time (especially in the Space and Time of Conflict). First of all Tool. Sometimes Product could be used as well.
  - Resources of the Environment for the Specific Situation.
  - Resources of the super-systems of the Specific System
- Pay special attention for structure of those operational Substances and Fields as well as for potential derivative resources that could be obtained out of the resources.
- Involve System Operator for each of those resources.

ANALYSIS OF IFR(S) AND CONTRADICTIONS OF CONTROL PARAMETER(S)

Important Comments

From now we start to construct (to form) a Mental Image (OTSM ENV model) of a satisfactory solution: property by property value by value. Often new concepts can not be adequately described in words. We have to switch on our imagination and sometimes switch off reasoning and cause effect links.

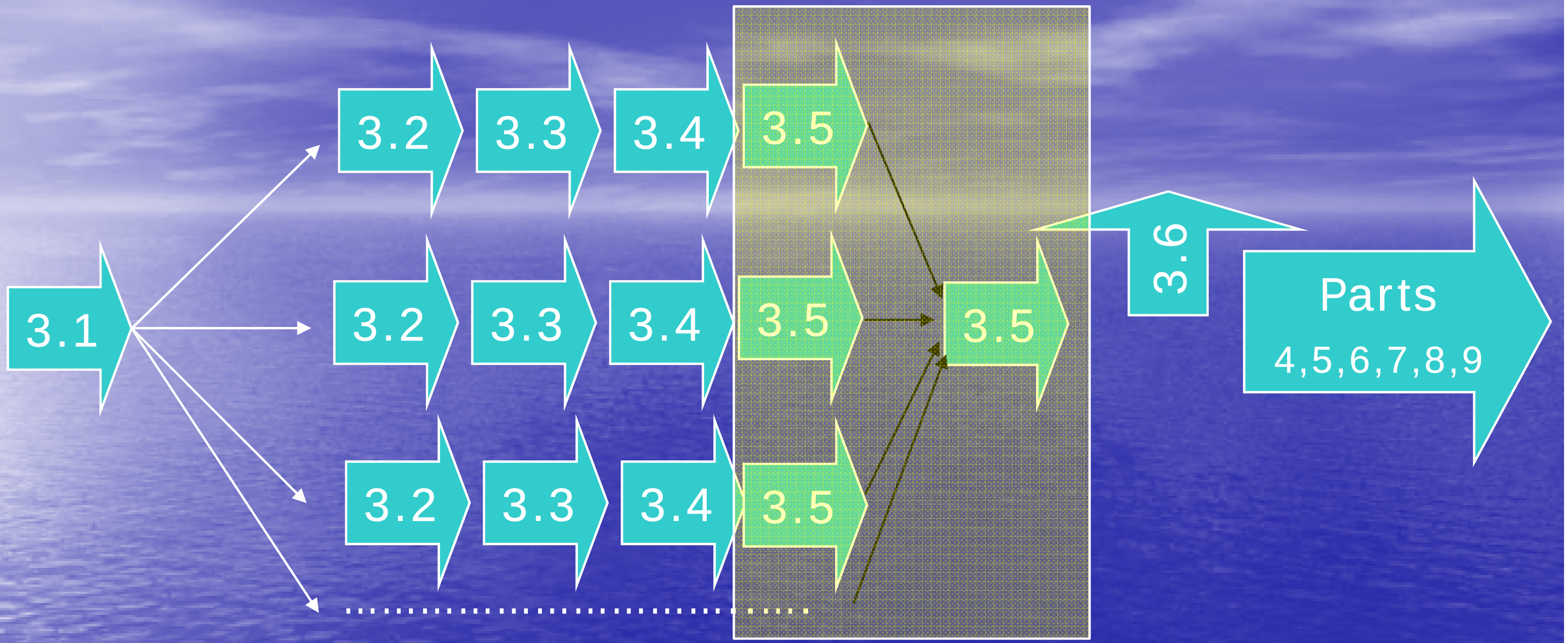
We have to keep in mind OTSM Axioms of Impossibility and Reflection as well as OTSM System Operator (OTSM ENV model).

Professional Knowledge will be involved not only from the domain where problem aroused but also from the domain that solution could belong to.

It is one more advantage of TRIZ and OTSM – they show what knowledge we have lack of and direct us to the specific domain where we can find it.

However, when applying ARIZ it is necessary to describe the analysis using simple, non-technical, even "childish" words, avoiding special terms (since they increase mental inertia).

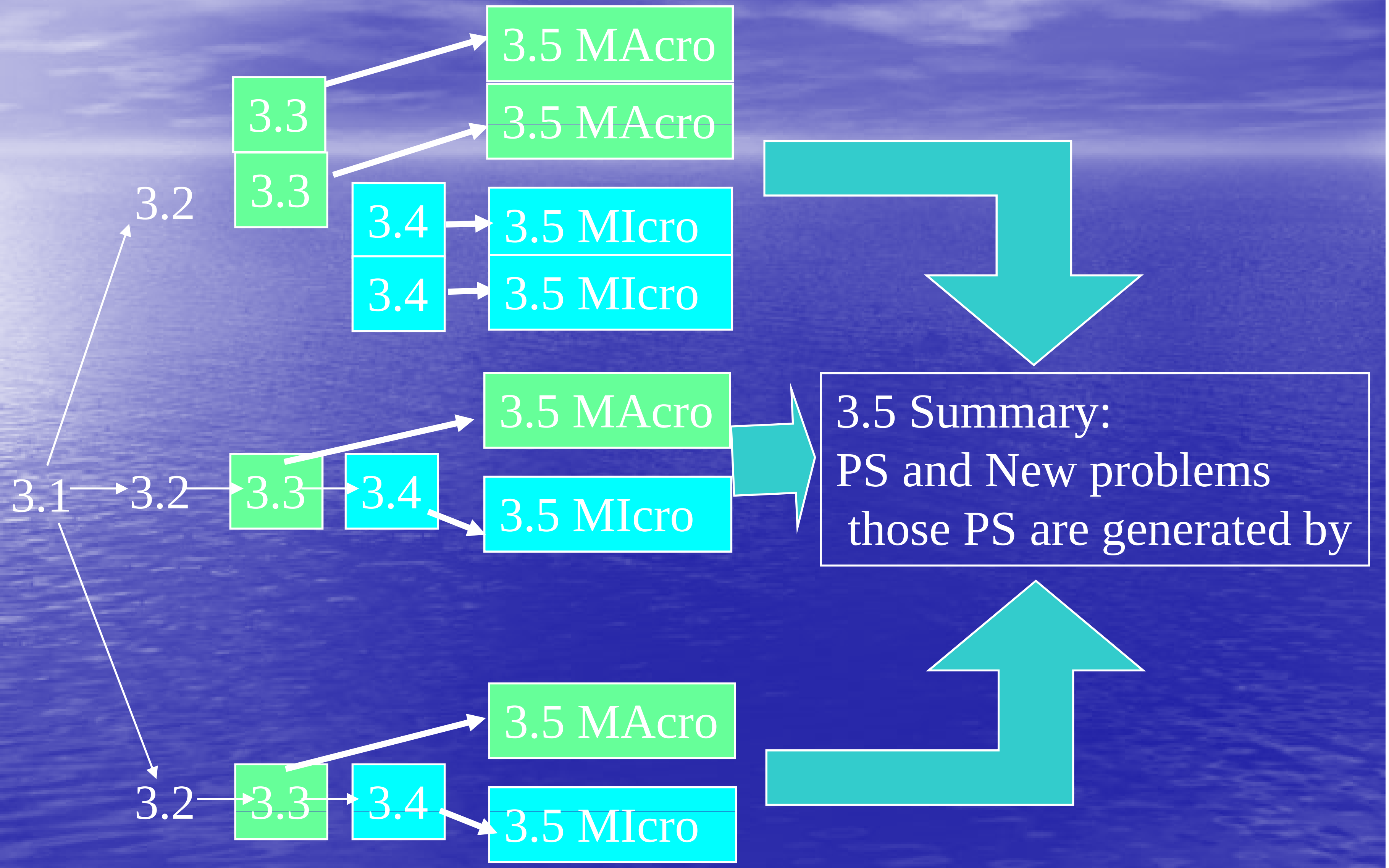
OTSM Interpretation of the step 3.5 (ARIZ-85-C)



- In part 3 we analyze the ability of available resources to solve the problem.
- Step 3.1. is dedicated to preparing a template for the analysis.
- During the analysis some new partial solutions appear.
- Step 3.5. is dedicated to constructing a new perception of the problem which is based on reflections of the analysis was done and the convergence of obtained partial solutions .

Classical TRIZ Problem Solving Process: Parallel Model

(Classical TRIZ problem solving Model since ARIZ-85-C)



IFR-1: Template to Analyze Substance-Field resources

(See also Altshuller's ARIZ, step 3.1.)

1. The system of X-modifications (X-Element),
2. without complication of the system and without negative side effects for MPP,
3. Eliminates <description of the Negative Effect>
6. and keeps the ability of the <tool> to provide <description of the Positive Effect>
5. inside the <Conflict Space(s)>
4. during the <Conflict Time Interval(s)>

IFR-1: Preparation Template to Analyze SFR

(See also Altshuller's ARIZ, step 3.1.)

- This step could not be done just by copy paste from previous steps. It is for thinking but not instead of it.
- One more time we should check professional terminology and remove it if any.
- One more time we should reformulate Descriptions of all components of the template in order to be sure about What, When and Where should be eliminated and kept.
- It is a reflection stage as well. We Reformulate our problem one more time to prepare next steps and to check correctness of all previous ones.
- All of this we have to do to prepare template for the step 3.2. based on the work was done before part 3.

Intensify the definition of IFR-1 (analog ARIZ 3.2.)

- Replace:

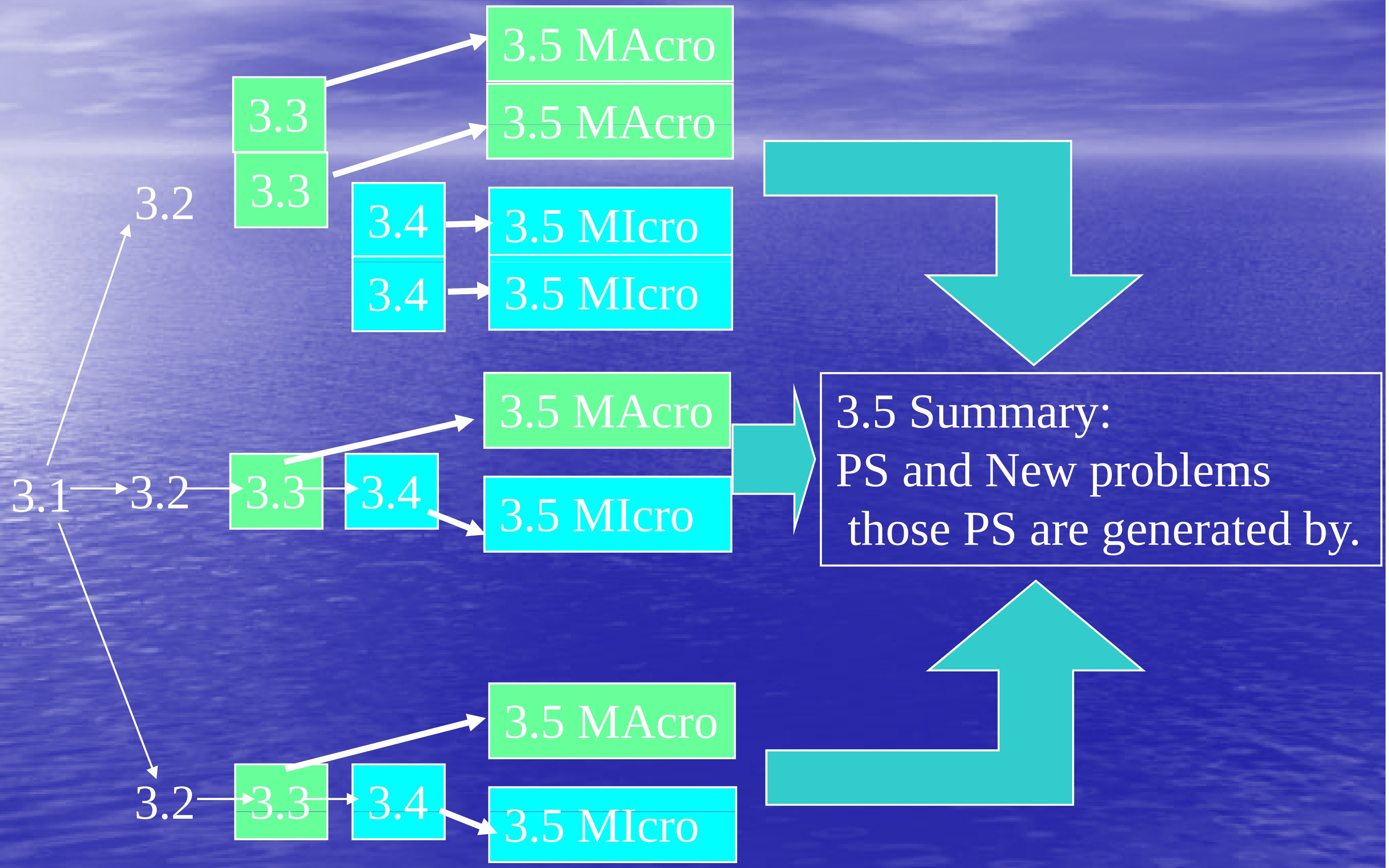
  "The system of X-modifications or X-Element"
- By:

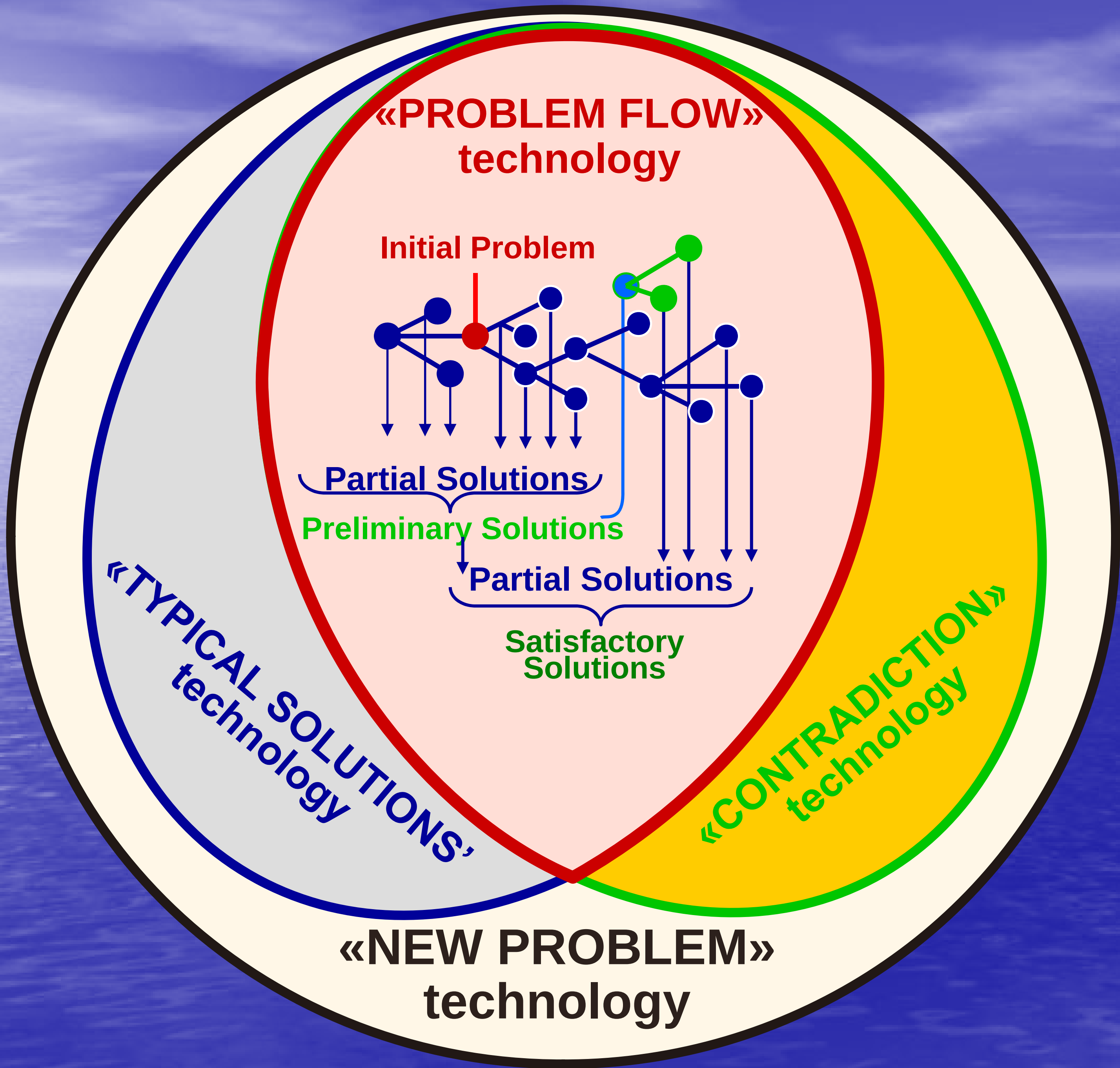
  "<The name of the Recourse> by itself"

- This could not be done just as a copy-paste operation. It is an operation for thinking: We should identify List of Control Parameters of the Recourse which must change its value to eliminate Negative Effect – Negative value of an appropriate Evaluation Parameter.

- Next several steps should be done for Each Parameter of the List of Control Parameters before come back to this step and switch to Next Recourse Name. Each of those next procedure could contribute additional details to form Image of satisfactory solution.

Altshuller’s ARIZ-85-C: Step 3.5. (OTSM viewpoint)
Classical TRIZ or OTSM Principles of contradiction resolution should be applied.
Keep in mind OTSM Fractal Model of a problem solving process.

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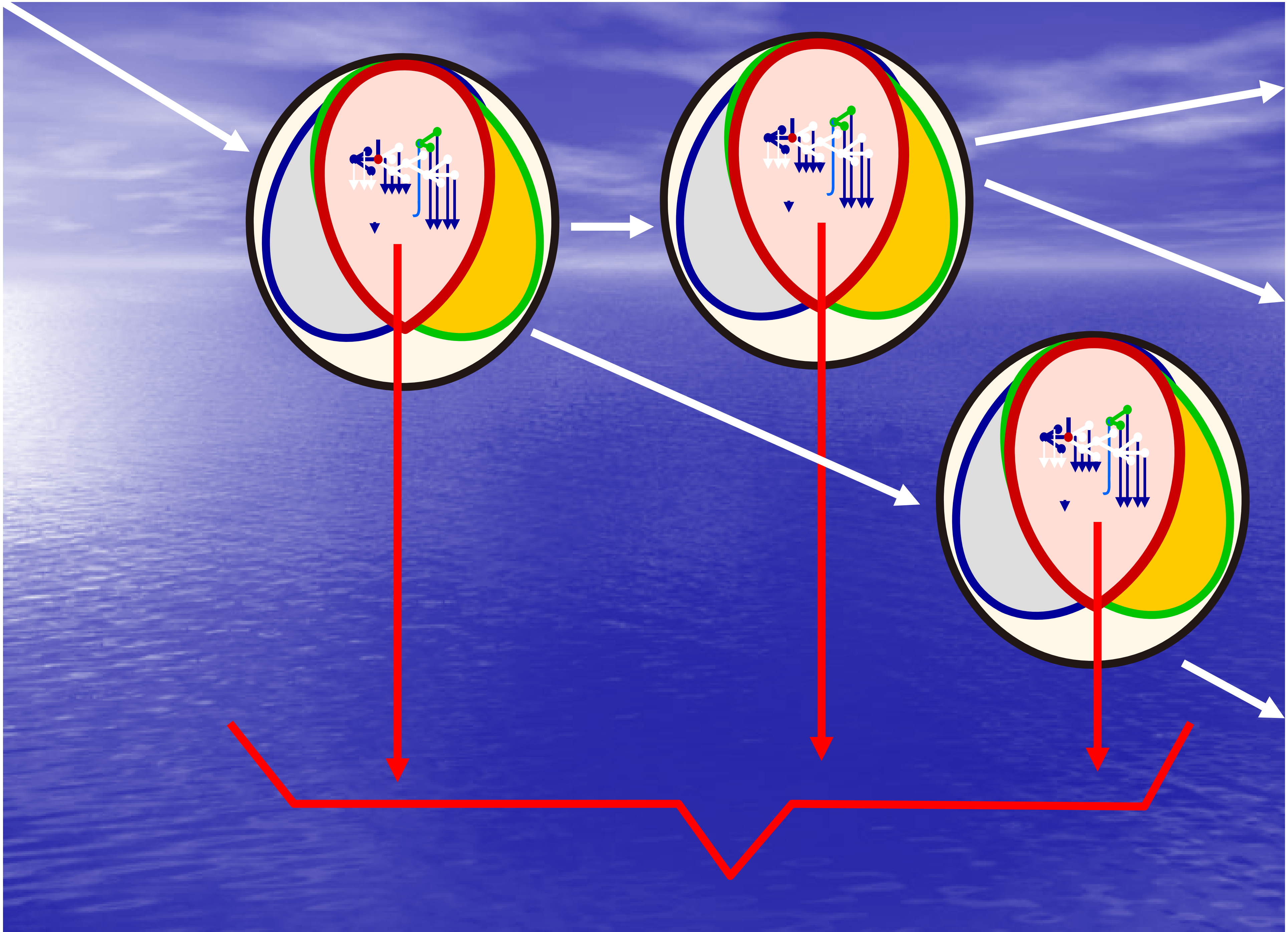
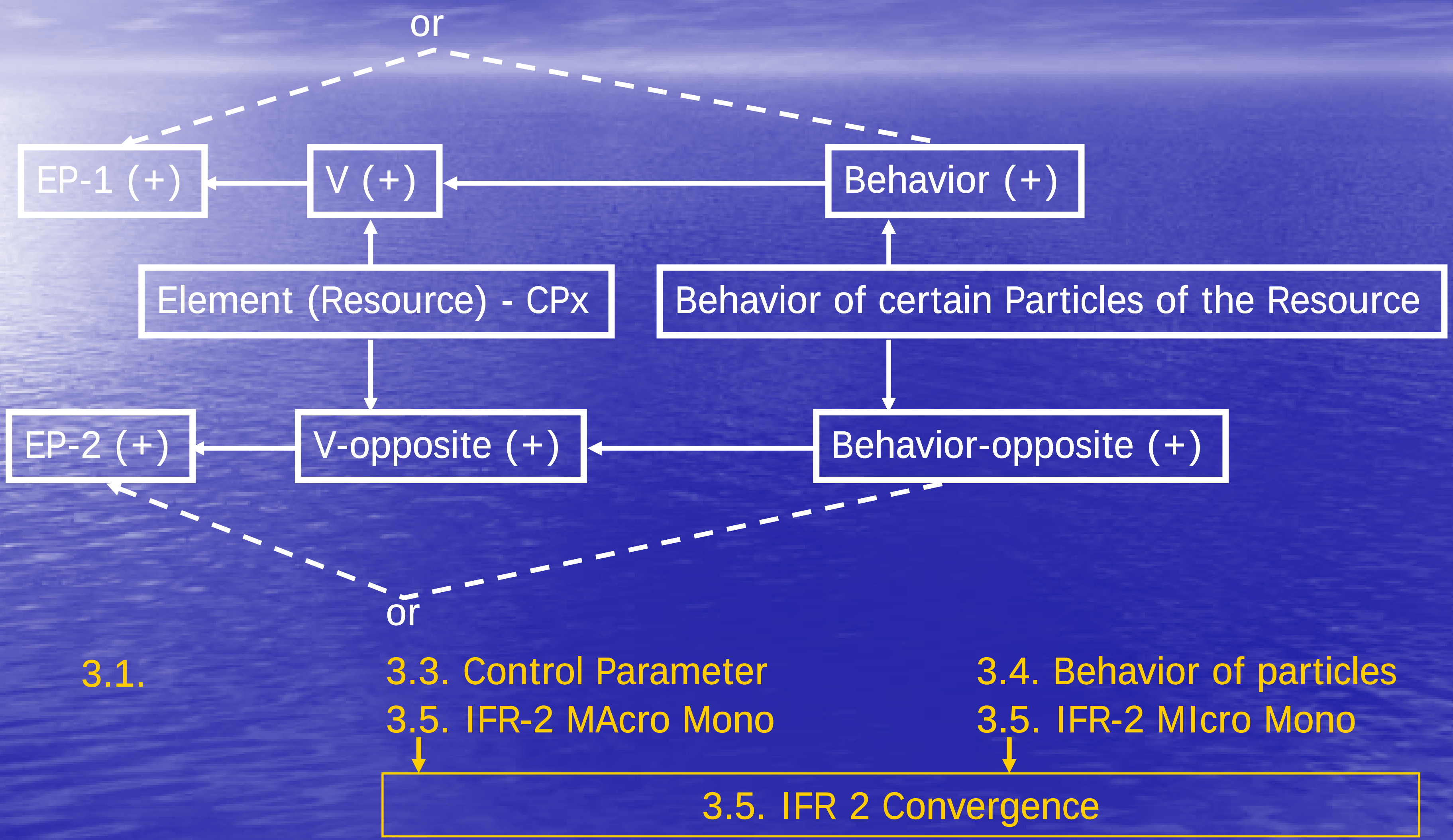


IFR-2 MAcro, MIcro and Convergence of them



Identify Contradiction of the Control Parameter MAcro-level (analog ARIZ 3.3.)

- Identify the Two Opposite Value for the one of Control Parameters chosen from the List was done on the previous step.
- One Value should be necessary to eliminate Negative Effect: Undesirable Value of the Evaluation Parameter.
- Opposite Value should be necessary to keep Positive Effect: Desirable Value of the another Evaluation parameter.
- Be careful with the situation when it is difficult to formulate this contradiction. It could be either solution or mistake.

Template to describe the Contradiction of the Control Parameter

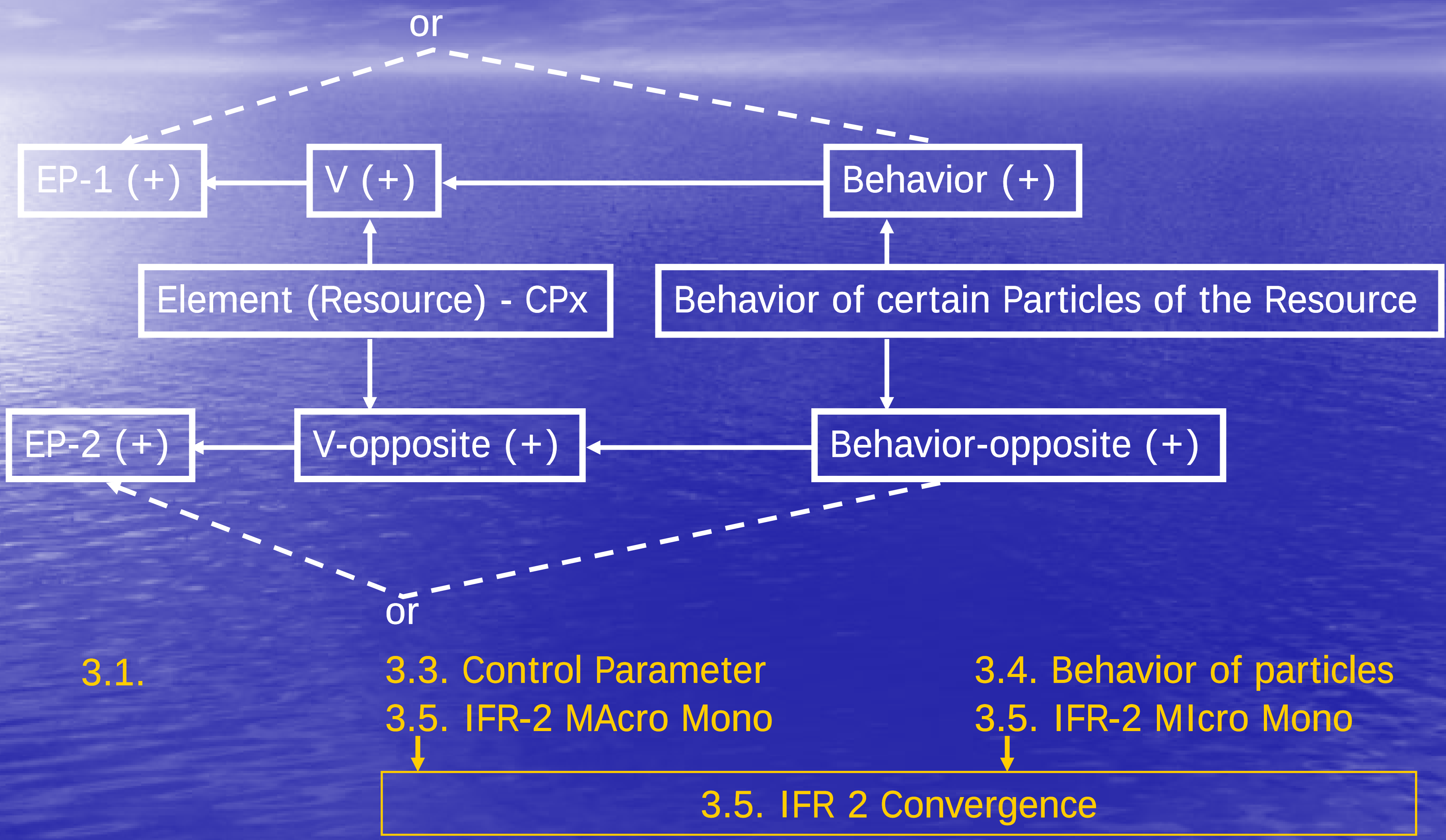
1. The <Control Parameter> of the <Resource>
2. In the <Space of Negative Effect>,
3. During the <Time interval of the Negative Effect>,
4. Must have Value <indicate physical macro-state (Value), for example "hot">
5. In order to eliminate the Negative Effect <Description of the Negative Effect>
6. And must have opposite value <indicate the opposite physical macro-state (Value), for example "cold“>
7. In the <Space of Positive Effect>,
8. During the <Time interval of the Positive Effect>,
9. In order to keep the Positive Effect <Description of the Positive Effect)>.

IFR-2 MAcro

- Substances and fields by them selves
- Have to provide convergence of Both Values of the Control Parameter: <Value one> and <Value opposite>
- In the <Conflict Space>,
- During the <Conflict Time interval>
- The way that both EP-1 and EP-2 will have desirable values: <Positive Value of EP-1> and <Positive Value of EP-2>

Apply Classical TRIZ or OTSM Classification of methods to converge opposite values in order to eliminate the contradiction of the Control Parameter.

IFR-2 MAcro, MIcro and Convergence of them



Template to describe the Contradiction of the Little Particles (Men) behavior

1. The <Little Particles of> the <Resource>
2. In the <Conflict Space>,
3. During the <Conflict Time interval>,
4. In order to provide value of the Control Parameter: <value one of the Control Parameter from Macro Contradiction>
5. Must behave <indicate behavior of the particles in order to provide the value of the Control Parameter>

and

6. Must have opposite behavior <indicate behavior of the particles in order to provide opposite value of the Control Parameter>
7. In order to Provide <opposite value of the Control Parameter> .

IFR-2 MIcro

- Available Resources of Substances and fields by them selves
- Have to provide convergence of Both opposite behaviors of particles
- In the <Conflict Space>,
- During the <Conflict Time interval>
- The way that the Control Parameter will have both opposite values: <Value one> and <Value Opposite>.
- In order to keep <Positive values of one of the Evaluation Parameter> and eliminate <undesirable, negative values of the other Evaluation Parameter>.

Apply Crowds of Little Creatures method to formulate the contradiction and to converge both behaviors of those particles (Little Creatures). It must be different groups or crowds of Little Creatures (particles)

Converged IFR-2

- Describe in free form what has to be happening in the Conflict Space (and around) during Conflict Time interval (and around) in order to provide:
  <desirable values of EP-1>
  <desirable values of EP-2>
- Keep in mind OTSM Axiom of Impossibility (OTSM problem Flow technology.

ADDITIONAL TRIKS COULD BE USED TO ACHIEVE IFR-2

To achieve IFR-2 could be used:
(see also Altshuller's ARIZ part 4,5 and comments)

- 4.1. simulation with little creatures
- 4.2. take a "step back" from the IFR
- 4.3. using a combination of substance resources
- 4.4. using "voids"
- 4.5. using derived resources
- 4.6. using an electrical field
- 4.7. using a field and field-sensitive substance

To achieve IFR-2 could be used:
(see also Altshuller's ARIZ part 4,5 and comments)

- 5.1. applying the System of Standard solutions for Inventive problems
- 5.2. applying the problems-analogue
- 5.3. applying Principles for Eliminating Physical Contradictions
- 5.4. applying the Pointer to Physical Effects and Phenomena

What should be done if satisfactory solution does not appear?

- Use OTSM Network of problem to correct the problem to be solved.
- Correct Network of problems.
- Plan research activity to cover the gape in available knowledge, or invite appropriate experts.

Recent examples:

Device for optical fiber connection.

Biogas power plant.

EVALUATION OF SOLUTIONS

How evaluate Partial and Satisfactory solutions

- Partial Solutions:
  - Does the partial solutions has any positive ideas?
  - Does the solution concept provide the main requirement of IFR-1 (the element without complicating the system...)?
  - Which Physical Contradiction (if any) is resolved by the solution concept?
  - Does the new system contain at least one easily controlled element? Which element? How is it controlled?
  - Does the solution concept found for the "single-cycle" Problem Model fit the real conditions, multi-cycle conditions?
  - Estimate the changes to the super-system and environment.
- Satisfactory Solutions:
  - Use OTSM Maps of problem situation: Networks of problems, contradictions and Parameters (specific and general)

REFLECTION ON THE PROBLEM SOLVING PROCESS

Reflection is one of the most important stage of a problem solving process.

- In the course of problem solving process OTSM Axiom of reflection should be used regularly:
  - As a problem solver:
    - As a “Student” who did an assignment.
    - As a “Teacher” who check homework of a “Student”.
    - As a judge between “Teacher” and “Student”
- As an independent observer-researcher.
  - What and why were done in the course of problem solving?
  - What was not done and why?
  - What should be improved in the problem solving toolbox?
  - How this improvement link with other potential improvement?
  - Does the improvement is a real improvement?
  - How the improvement could damage the problem solving toolbox?

Nikolai.Khomenko@gmail.com

www.trizminsk.org

www.jlproj.org

Insight Technologies Lab, Canada, Ontario.

THANK YOU FOR YOUR ATTENTION!