Identifying and Pursuing the Ideal Final Result with TRIZ

plus chemistry-based case studies

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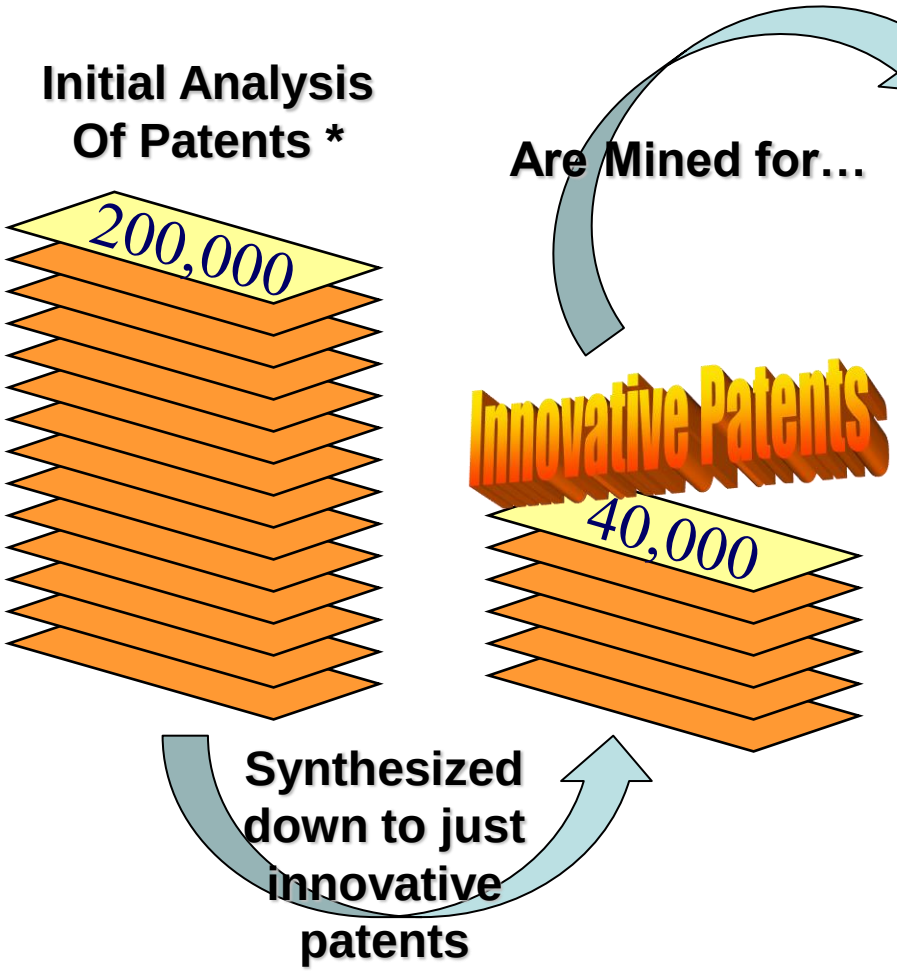
5/10/17

What is Inventive Problem Solving?

- 1946 – Genrich Altshuller, who worked in the Patent Inspector's Office of the Soviet Navy, began developing the Theory of Inventive Problem Solving (TRIZ)
  - Inventing is based on understanding and resolving contradictions
  - Every method used to solve contradictions can be summarized into a set of Inventive Principles

Genrich Altshuller. n.p., n.d. Web 10 June 2011
<http://cdn.gotoknow.org/assets/media/>

What is TRIZ?

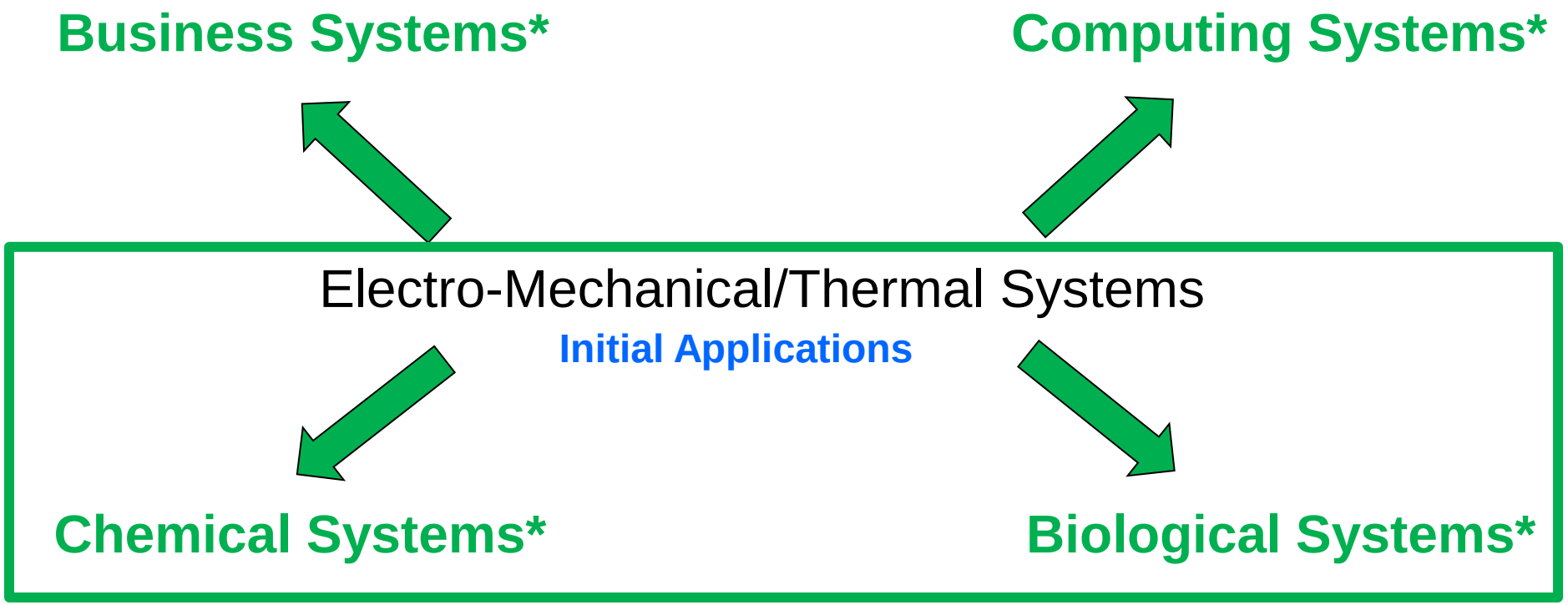


Key Discoveries

1. Problems and solutions were repeated across industries & sciences → **principles for solving Problems**
2. Patterns of technical evolution were repeated across industries & sciences → **technology trends to evolve a technical system to the next gen**
3. Innovations used scientific effects outside the field from where the original problem was found → **scientific effects can be used to solve problems in unique ways**

TRIZ family of principles, and strategies enabling engineers to identify potential solution paths of technical problems.

Applications of the Theory of Inventive Problem Solving



*Expanded Applications

TRIZ Focus Areas

Ideality – The expression of the ultimate system where value is maximized by expanding functionality and minimizing cost and harmful effect.

Defines the ultimate goal

Contradiction - A situation where an improvement in one characteristic of a system results in the degradation of another characteristic.

Establishes why the goal currently can not be reached

Resource Analysis – a list of the substances, fields, and their properties in the area of operation that can be utilized in solving an identified conflict between system components.

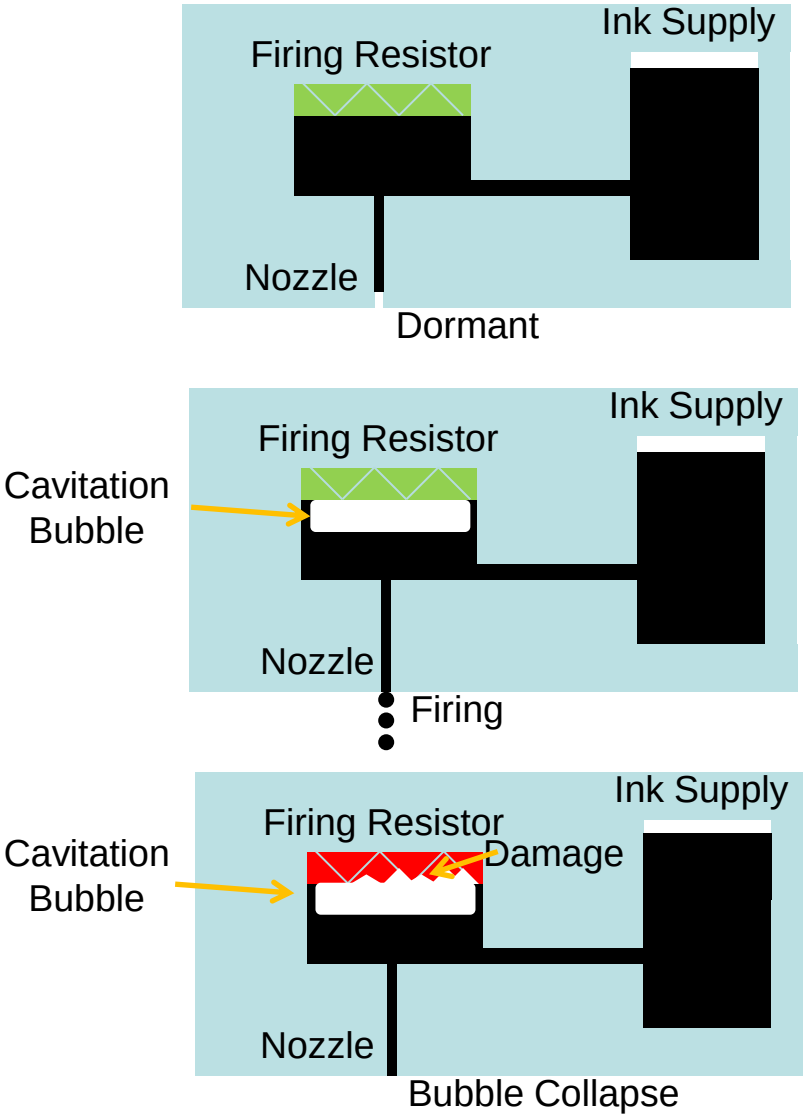
Identifies availability of "things" to apply towards solutions

Trend of System Evolution - Directions of system development that describe the natural transitions of the systems from one state to another.

Reveals typical historical changes to systems in support of solution generation

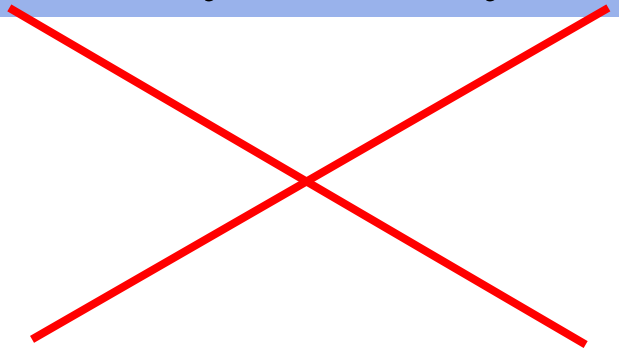
Case Study – Ideality, Contradictions, Resources and Trends

Ink Jet Resistor Damage

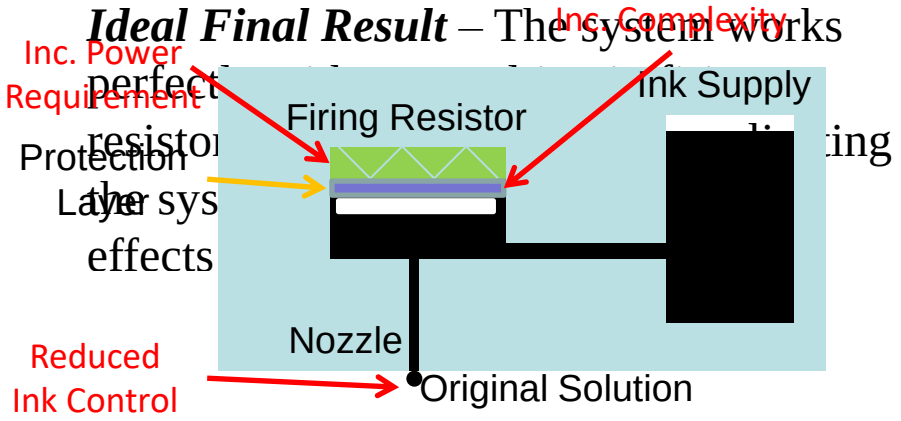


Ideal Final Result – The system works perfectly without resulting in firing resistor damage and without complicating the system or creating other harmful effects

Case Study – Ideality, Contradictions, Resources and Trends



Ideal Final Result – The system works perfect… resistor… the sys… effects…



Ideal Final Result? – The originally applied solution is not ideal in that it:

1.) reduces the performance of the system

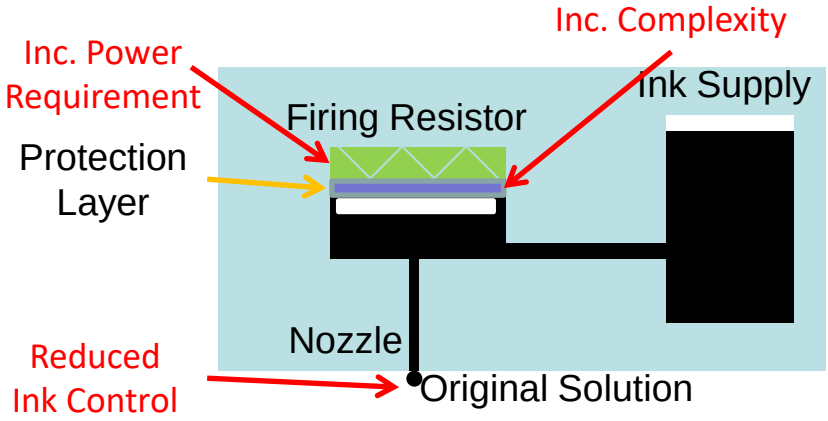
2.) makes the system more complex and therefore expensive

3.) increases the power required for operation

Therefore the systems value is not maximized but rather reduced.

Case Study – Ideality, Contradictions, Resources and Trends

Contradiction – IF a protective layer is added to the system, THEN damage to the firing resistor is avoided, BUT the system is complicated (-or- does not work as well –or- requires more power to operate)



Principle 22 – Blessing in Disguise – Use harmful factors to achieve a positive effect.

Principle 19 – Preliminary Anti-Action – If it will be necessary to do an action with both harmful and useful effects, the action should be replaced with and anti-action to control the harmful effects

Trend of Increasing Coordination - As an engineering systems evolves, characteristics of the components of the system become more coordinated with each other and the super-system.

Case Study – Ideality, Contradictions, Resources and Trends

Principle 22 – Blessing in Disguise – Use harmful factors to achieve a positive effect.

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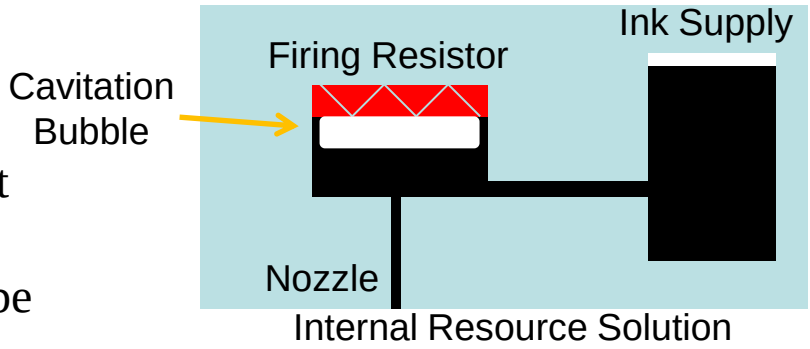
Trend of Increasing Coordination - As an engineering systems evolves, characteristics of the components of the system become more coordinated with each other and the super-system.

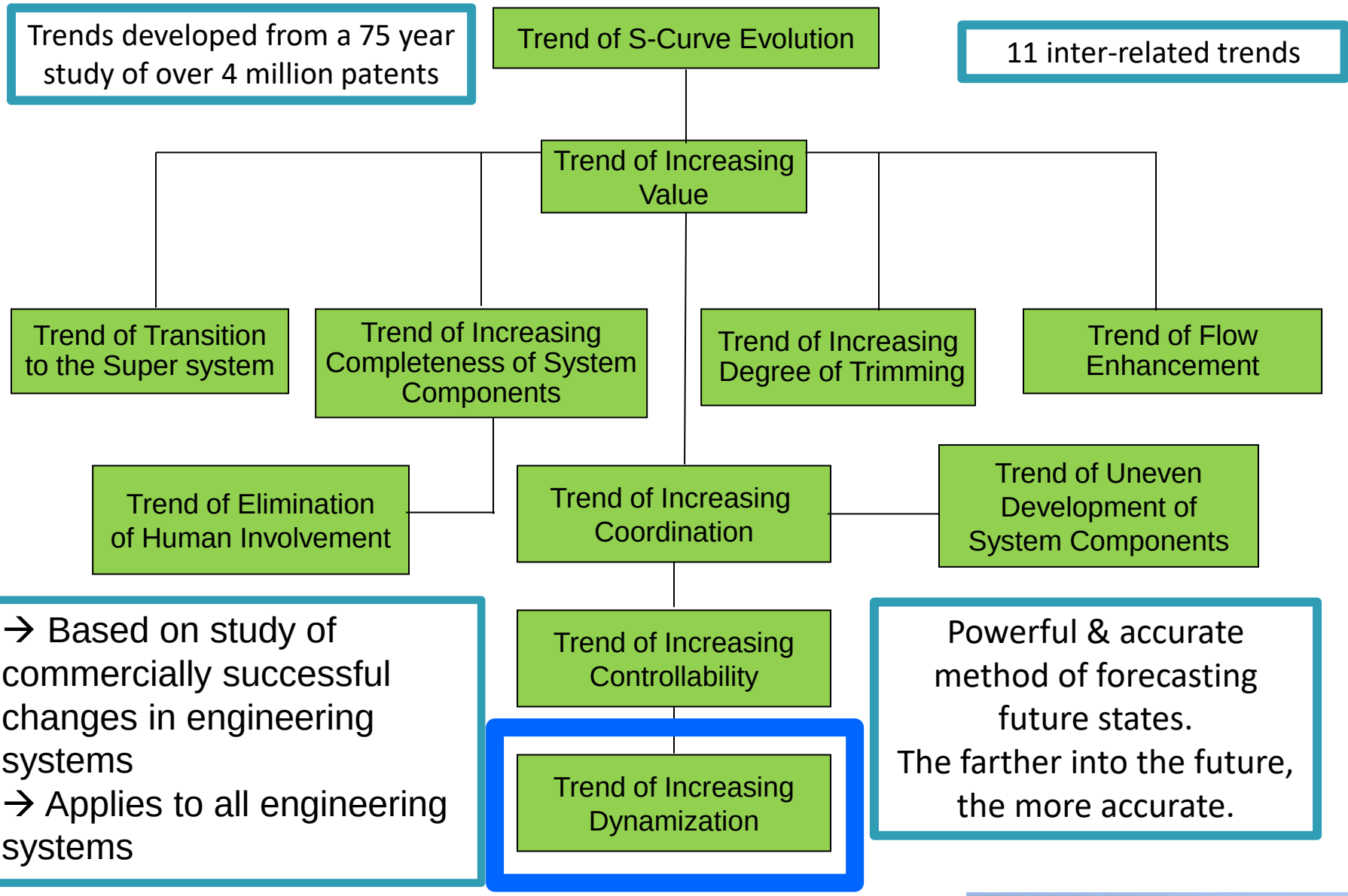
Secondary cavitation bubbles stop damage



What internal resources are available?

Ink
Nozzle
Cavities
Resistor
Heat
Cavitation Bubble

What are Trends of Engineering System Evolution?



Trends of Engineering System Evolution Overview

Trend of Increasing Dynamization

Example: Surfactant (soap)

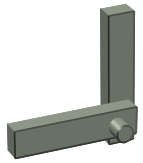
bar soap

Monolith

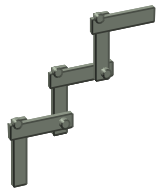
bar soap w/ additive

Monolith (differentiated parameters)

One Joint



Multi-joint



Elastic

elastic soap

Powder

powdered soap

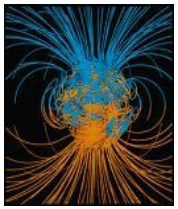
Liquid

liquid soap

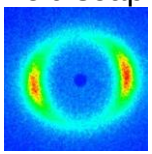
Gaseous

gas soap

Field



field soap



Thanks to Gen 3 Partners for use of some of the images

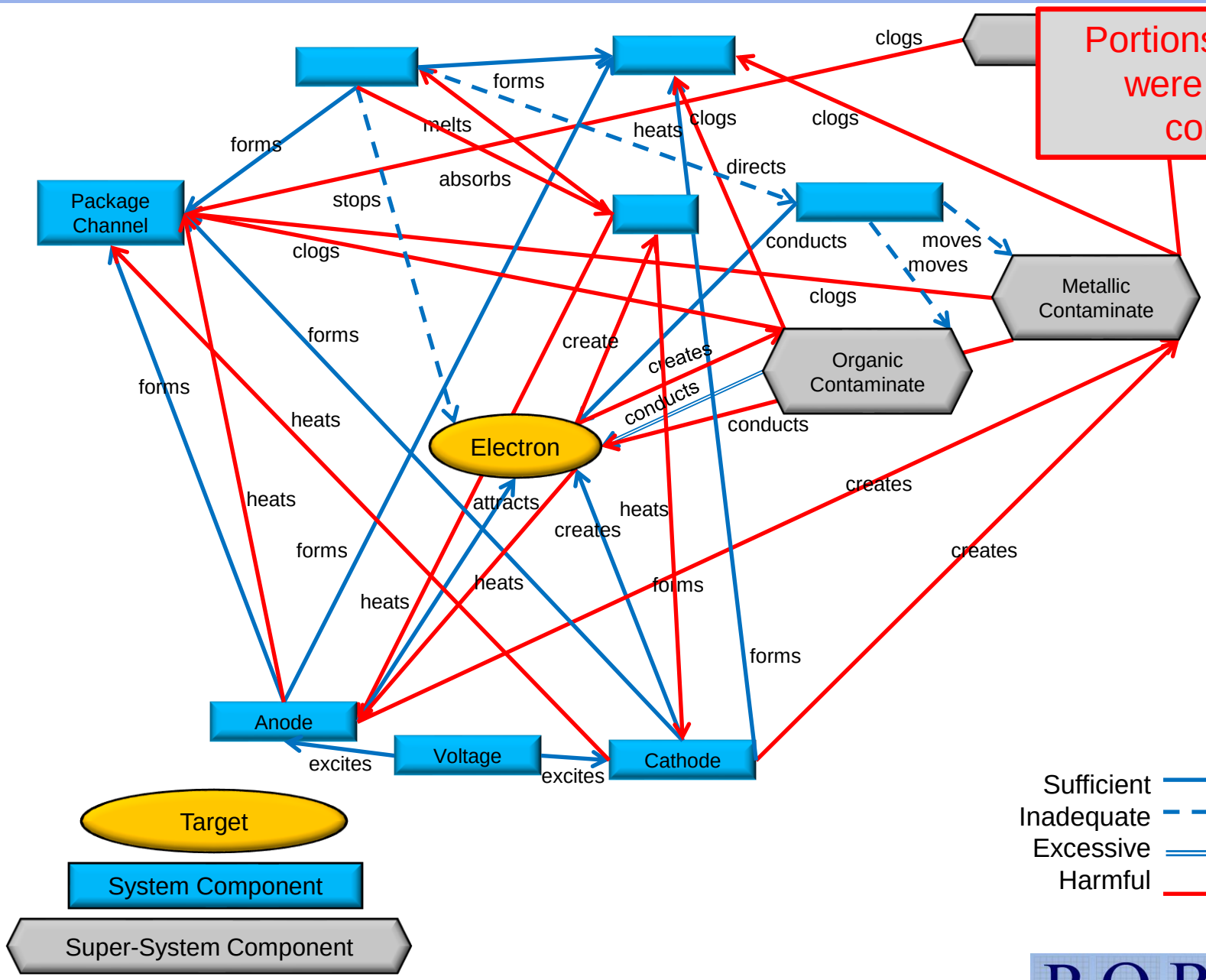
Extending Reactor Life

Electro-Mechanical/Thermal & Chemical Analysis
Case Study

Background and Problem Statement

- Problem Statement – organic and metallic materials clog package channels and cause shorts across cathode / anode gap
- How to increase the life of reactor package?

Functional Model – shows how system works and IDs issues



Focus Areas

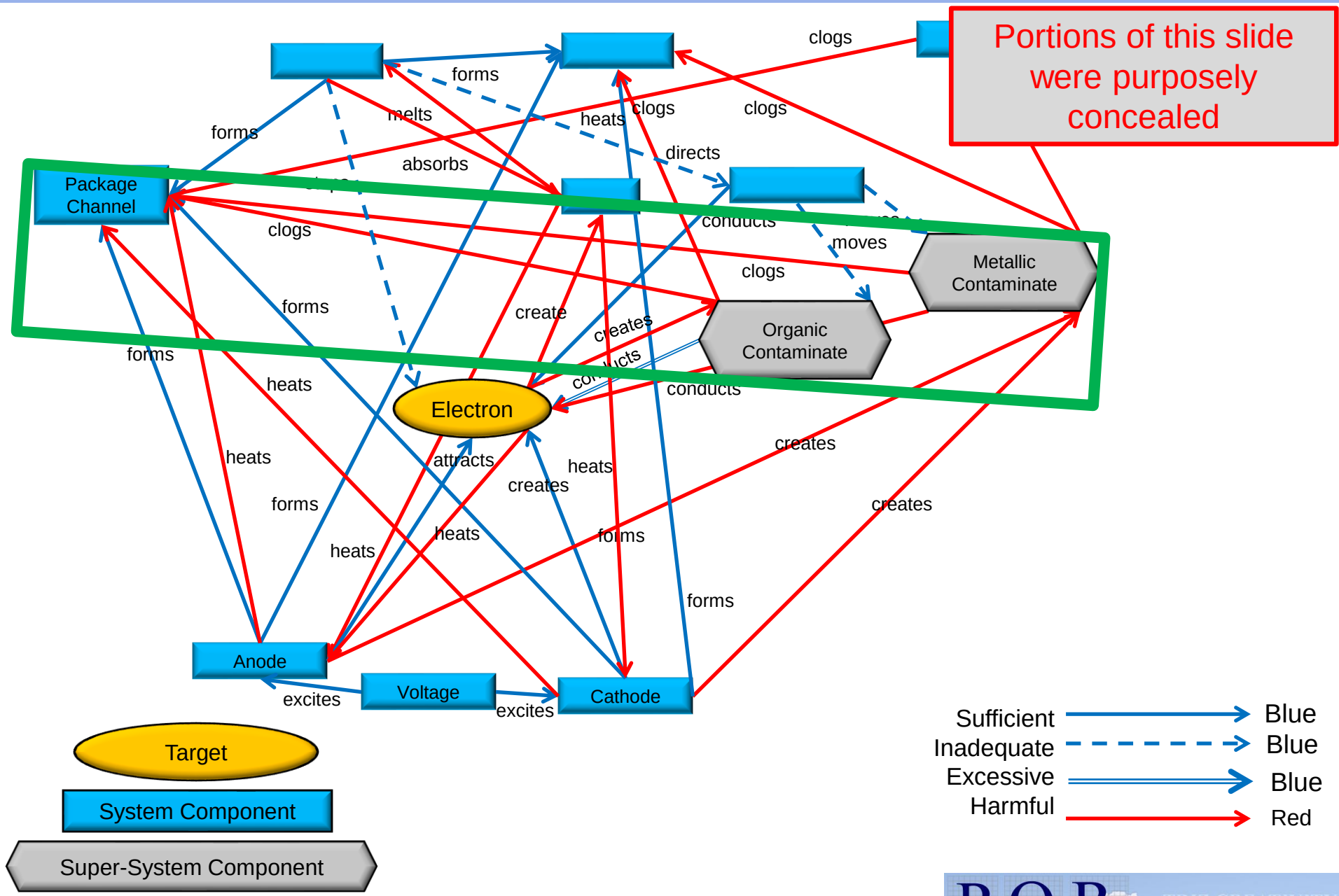
Ideality – Reactor preforms perfectly without any channel clogging or gap shorting and without complicating the system or harmful effects.

Contradiction – See next slides.

Resource Analysis – All item in and around the system: process chemicals, voltage, electrolyte, contaminates, channel, plastic cover, cathode, etc.

Trend of System Evolution – Various trends (e.g., trend of increasing coordination, trend of dynamization, etc.)

Functional Model – shows how system works and IDs issues



Sample Contradictions

- If the channel depth is small
- Then productivity is increased
- But the system is easily clogged by various materials

Two versions of contradiction associated with narrow channel width

- If the channel depth is small
- Then productivity is increased
- But foreign material can cause shorts across the cathode / anode gap

Sample Contradictions

- If the channel depth is small
- Then productivity is increased
- But the system is easily clogged by various materials

- Principle 22 – Blessing in Disguise – use “clogs” to change shape of a flexible anode/cathode to clear themselves
- Principle 35 – Parameter Change - switch from rectilinear to concentric pipe packages -or- change channel depth from time to time
- Principle 13 – The Other Way Around – reverse electrolyte flow from time to time
- Principle 24 – Intermediary – utilize filter screens to capture clogs and clean while in operation

Sample Contradictions

- If the channel depth is small
- Then productivity is increased
- But the system is easily clogged by various materials

Two versions of contradiction associated with narrow channel width

- If the channel depth is small
- Then productivity is increased
- But foreign material can cause shorts across the cathode / anode gap

Sample Contradictions

Principle 35 – Parameter Change - switch from rectilinear to concentric pipe packages -or- change channel depth from time to time
Principle 22 – Blessing in Disguise – use “clogs” to change shape of flexible anode/cathode to clear themselves
Principle 18 – Mechanical Vibration– utilize resonance frequency of foreign material to break-up and move the material
Principle 39 – Inert Atmosphere – neutralize foreign materials so that they are non-conductive

- If the channel depth is small
- Then productivity is increased
- But foreign material can cause shorts across the cathode / anode gap

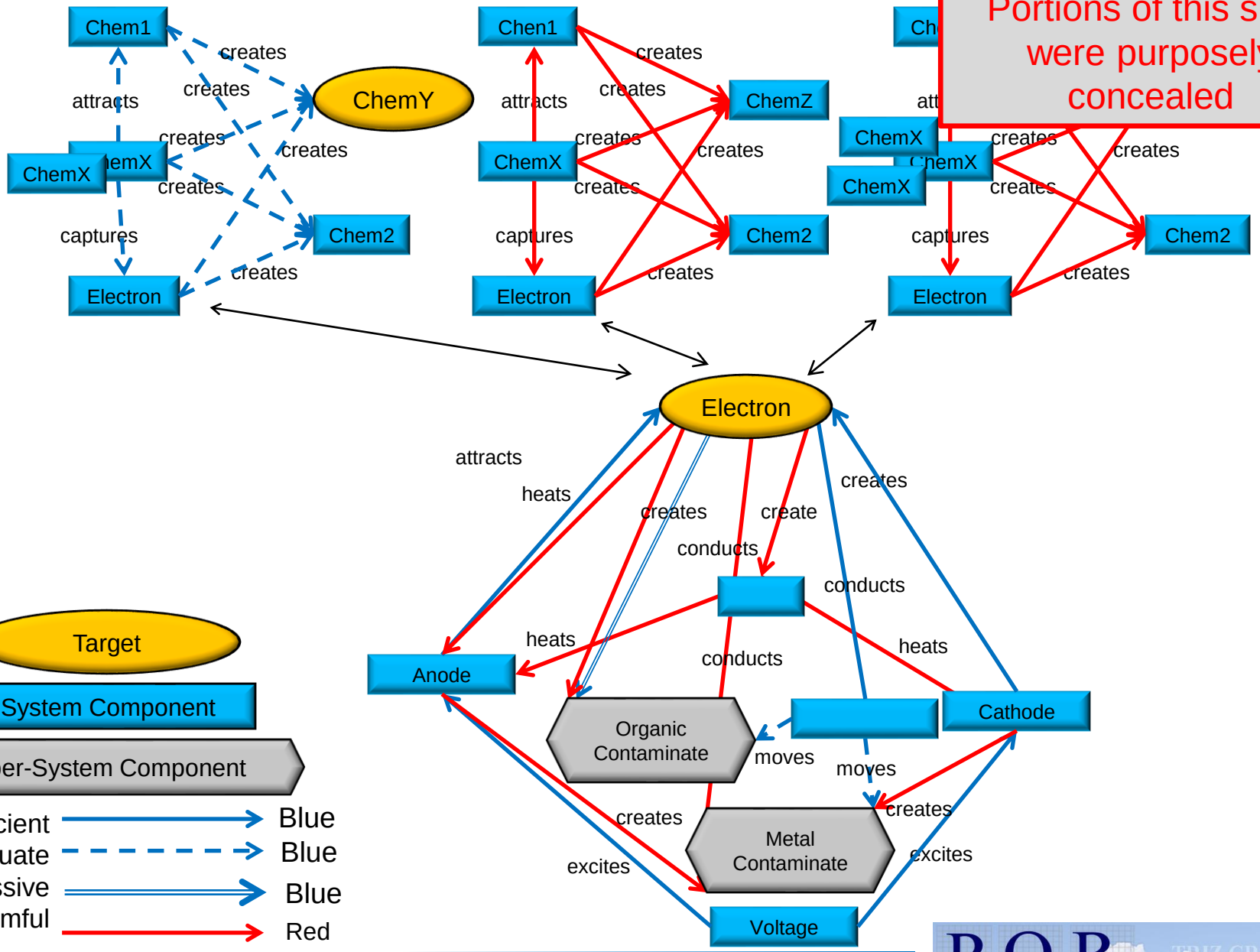
Production Selectivity

Electro-Mechanical/Thermal & Chemical Analysis
Case Study

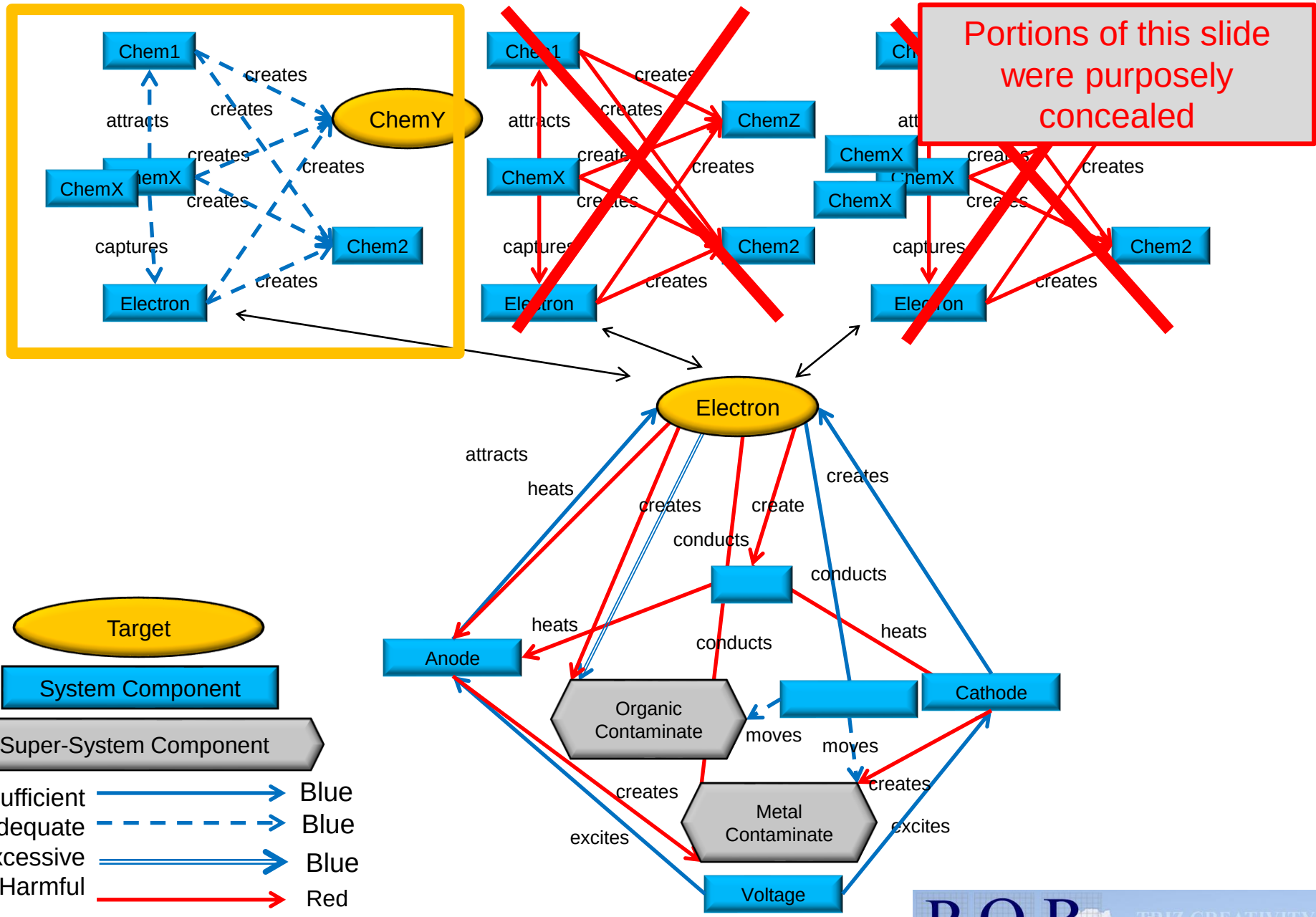
Background and Problem Statement

- Reactor works well but some of the productivity is “lost” in forming undesired output.
- How to increase productivity of process?

Functional Model



Functional Model



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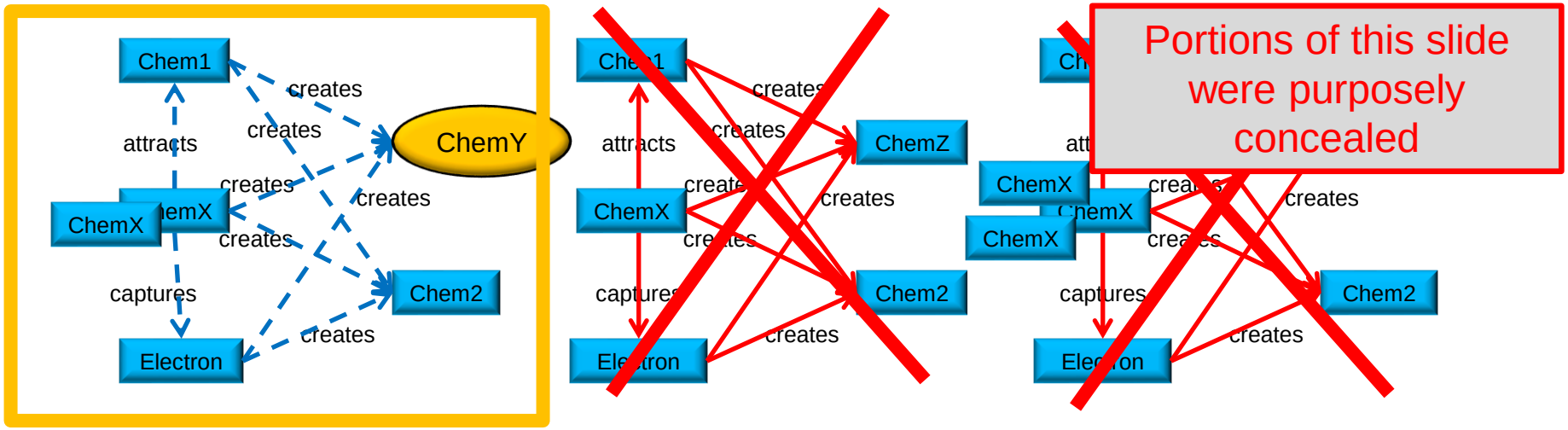


How do we select for the desired chemical reactions and avoid the undesired chemical reactions?

Ideal Final Result – The process always proceeds by an interaction involving two ChemX molecules without complicating the system or creating other harmful effects

Contradiction -

- If the system is used as is
- Then the process is not complicated
- But the required molecules do not always interact in the discreet quantities necessary to affect the desired reaction

SSRIs Antidepressant

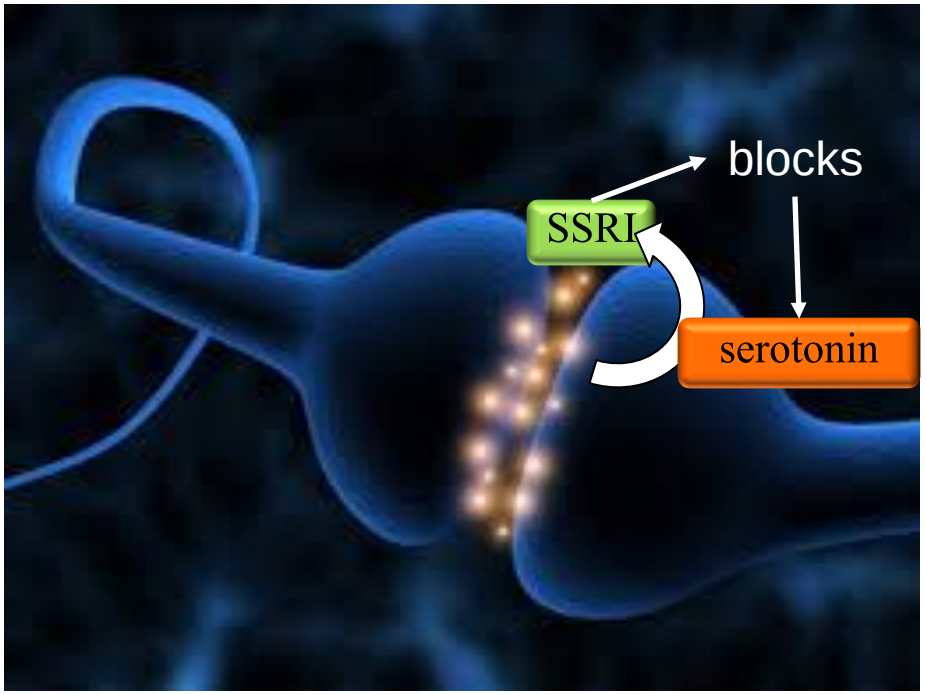
Selective serotonin reuptake inhibitor

Biological & Chemical Analysis Case Study

Case Study – Drug Interaction in Body

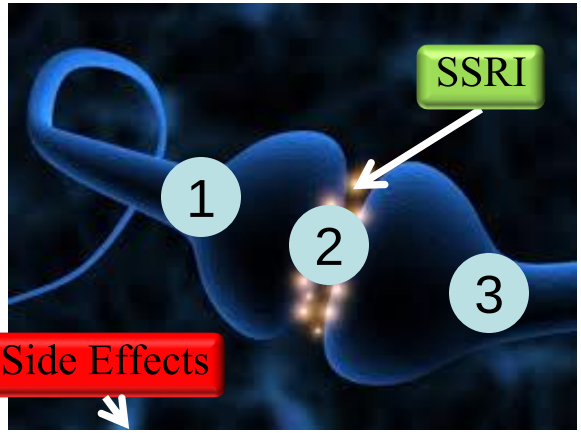
•Innovation direction for improvement of SSRI antidepressant

Selective serotonin reuptake inhibitor



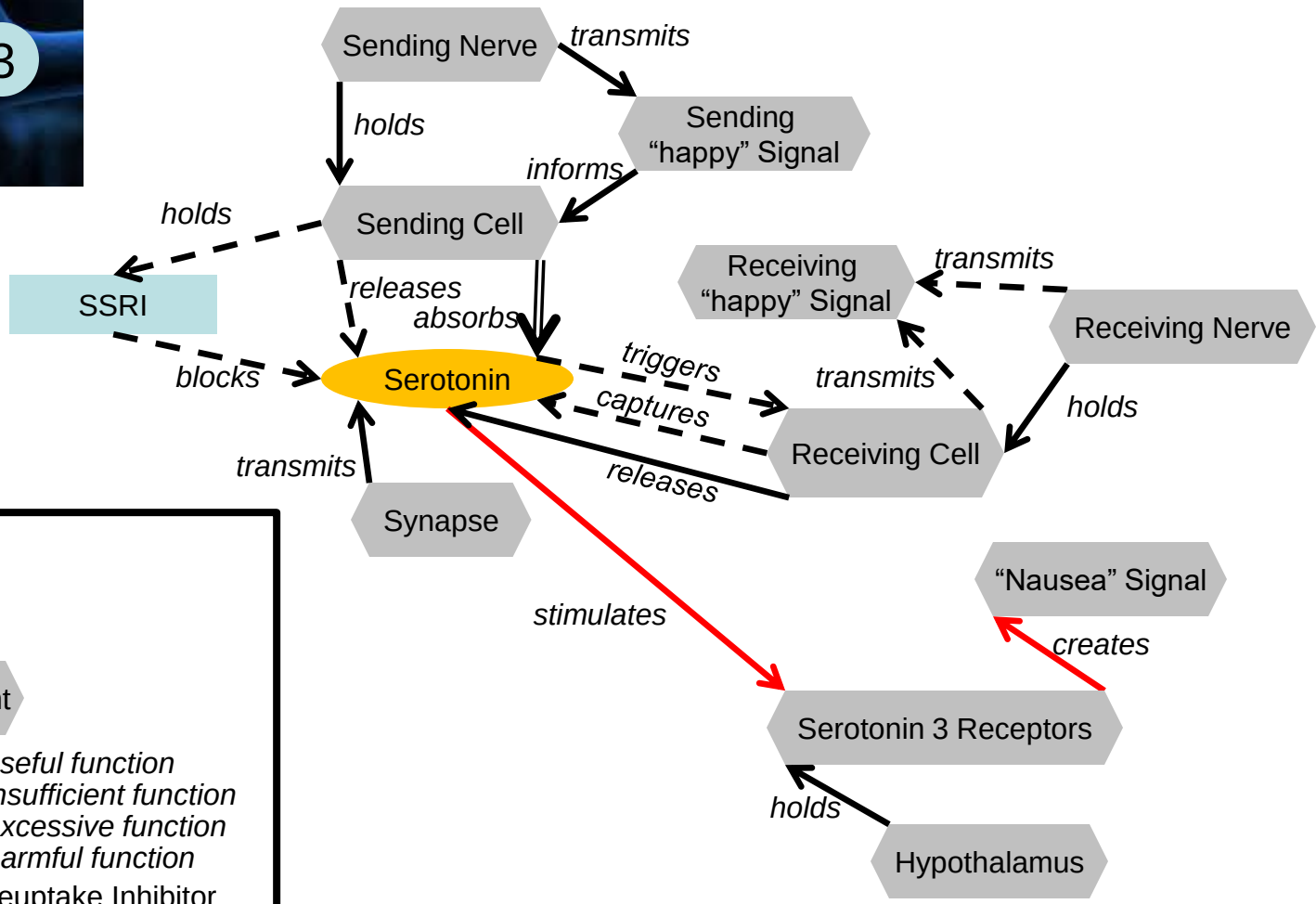
1.) In the brain, serotonin triggers a "happy signal" when absorbed by the receiving cell of the synapse
2.) Individuals experiencing depression often have less serotonin than non-depressed individuals
3.) The synapse sending cell not only expels, but also absorbs, serotonin thus making it unavailable to trigger the "happy signal" in the receiving cell
4.) SSRIs focus on stopping the serotonin sending cell from reabsorbing the serotonin thus effectively increasing serotonin available for uptake by receiving cell

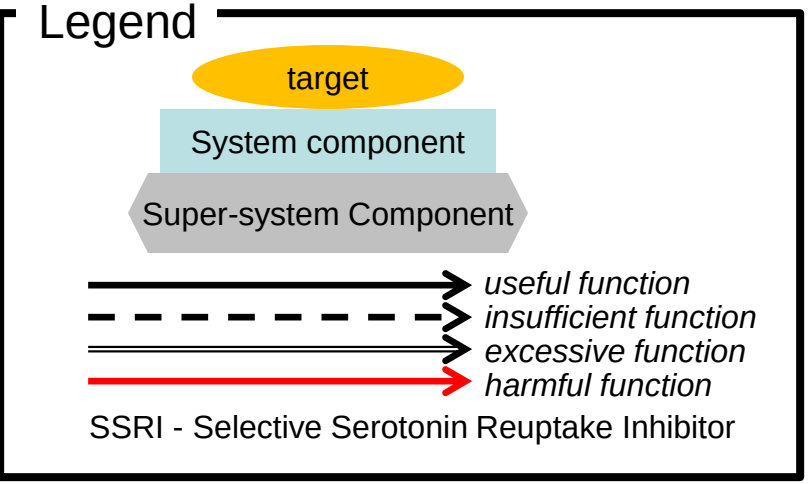
Case Study – Drug Interaction in Body



- Innovation direction for improvement of SSRI antidepressant

Selective serotonin reuptake inhibitor

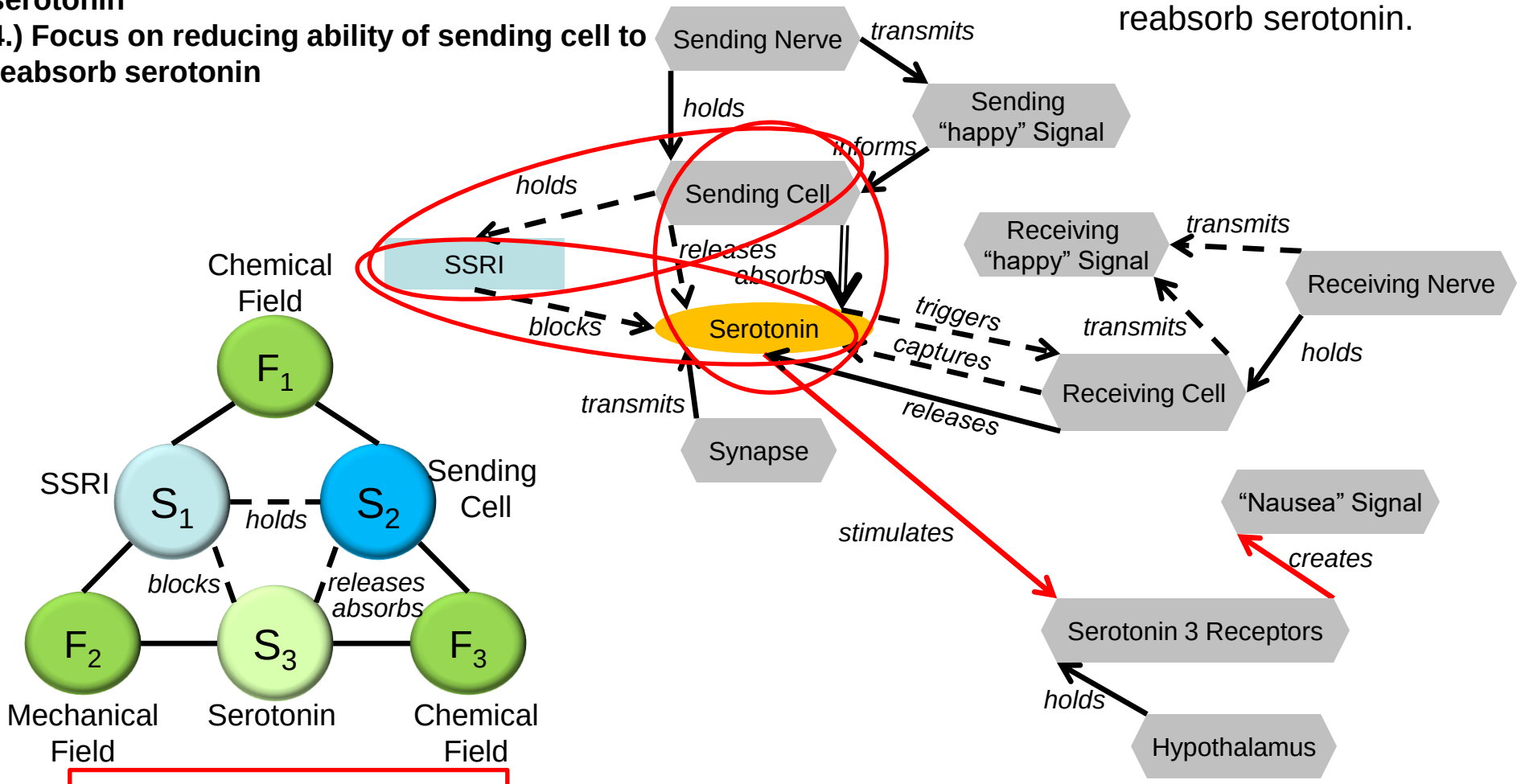




Case Study – Drug Interaction in Body

1.) Focus on sending cells ability to hold SSRI
2.) Focus on ability of SSRI to block serotonin
3.) Focus on ability of sending cell to release serotonin
4.) Focus on reducing ability of sending cell to reabsorb serotonin

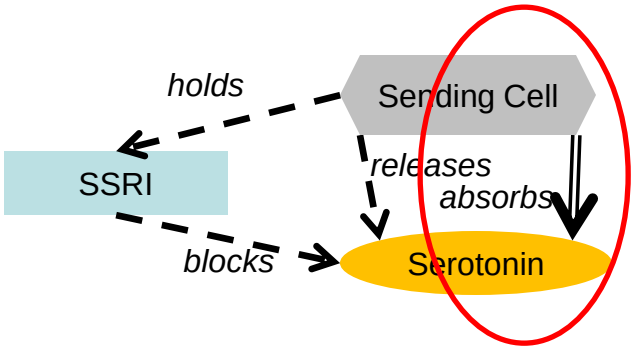
Advancements focusing on use of SSRI to reduce sending cells ability to reabsorb serotonin.

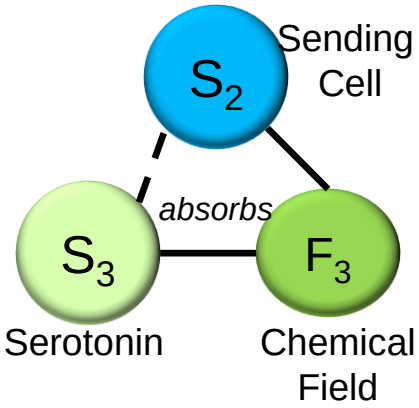


Case Study – Drug Interaction in Body

Advancements focusing on use of SSRI to reduce sending cells ability to reabsorb serotonin.

4.) Focus on reducing ability of sending cell to reabsorb serotonin





Case Study – Drug Interaction in Body

Once functions are understood TRIZ suggests innovation pathways.

Multiple Su-fields

- Chain Su-Field Model
- Double Su-Field Model

Enforcing Su-Field Models

Applying More Controllable Fields

- Applying More Controllable Fields
- Fragmentation of S_2
- Applying Capillary and Porous Substances
- Dynamization
- Structuring Fields
- Structuring Substances

Enforcing by Matching Rhythms

- Matching Rhythms of F and S_1 or S_2
- Matching Rhythms of F_1 and F_2
- Matching Incompatible or Previously Independent Actions

Use EM Fields/Substances

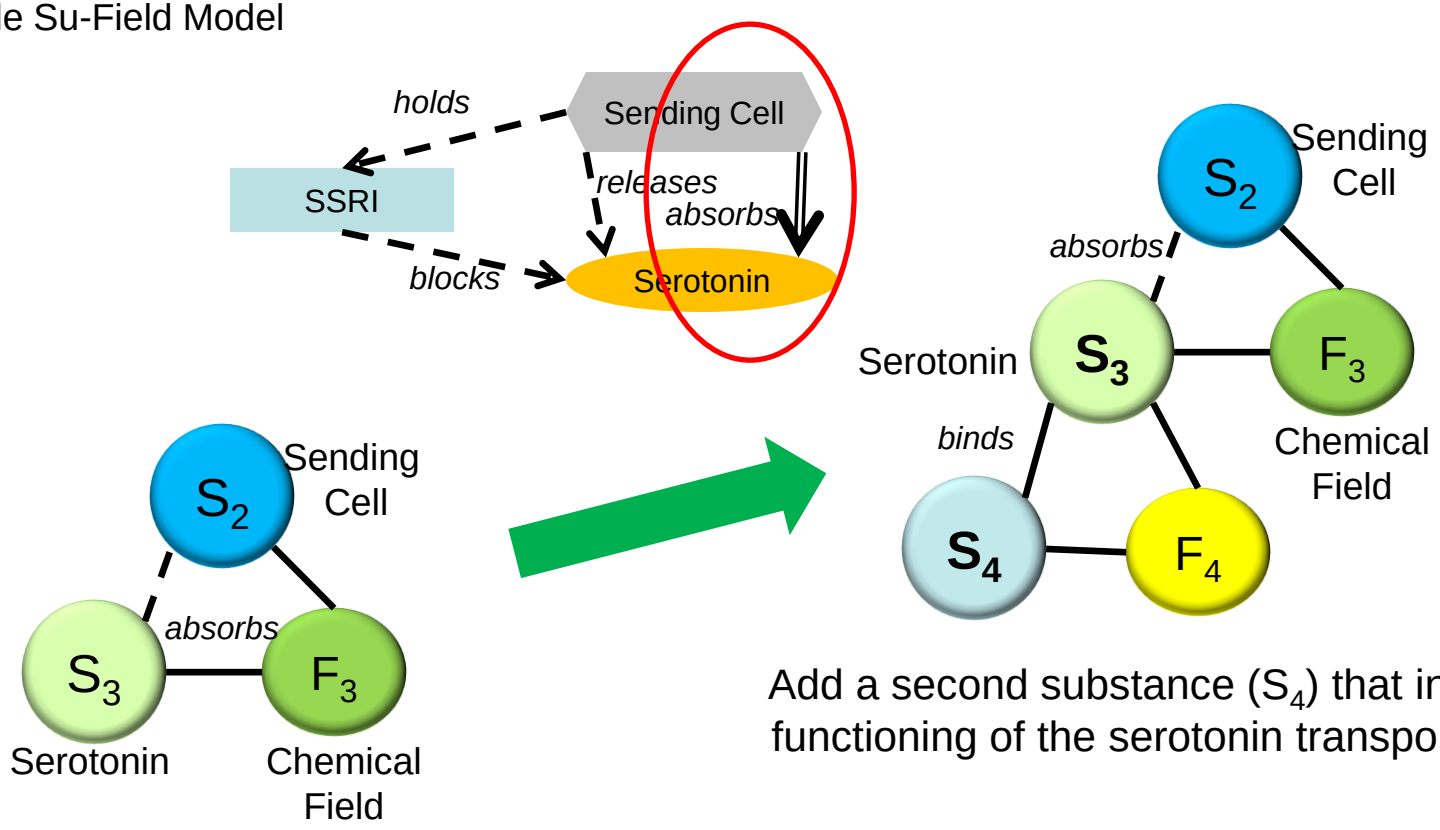
- Pre-Ferro-Field Models
- Ferro-Field Models
- Electro-Magnetic Liquids
- Applying Capillary Structures in Ferro-Field Models
- Complex Ferro-Field Models
- Ferro-Field Models with the Environment
- Applying Physical Effects and Phenomena
- Dynamization
- Structuring
- Matching Rhythms in Ferro-Field Models
- Electro-Field Models
- Rheological Liquids

Case Study – Drug Interaction in Body

Advancements focusing on use of SSRI to reduce sending cells ability to reabsorb serotonin.

Multiple Su-fields

- Chain Su-Field Model
- Double Su-Field Model



Add a second substance (S_4) that inhibits the functioning of the serotonin transport protein.

Case Study – Drug Interaction in Body

6 Formulation Investigation Options:

1.) add a substance that binds with the transporter protein's sodium ion's binding site

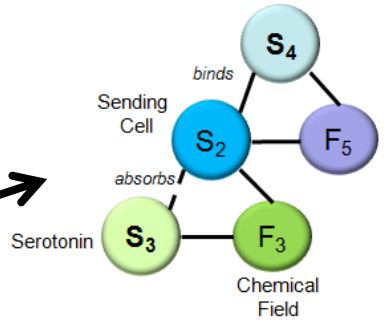
2.) add a substance that binds with transporter protein's chloride ion's binding site

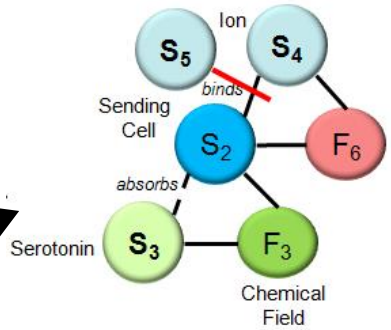
3.) add a substance that binds with transporter protein's serotonin's bind site

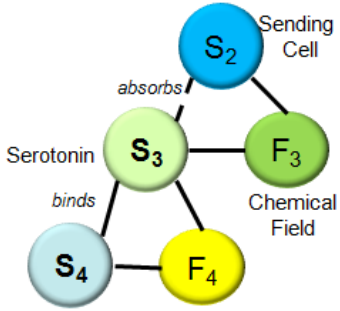
4.) add a substance that binds with the sodium ion and prevents it from binding with the transporter protein

5.) add a substance that binds with the chloride ion and prevents it from binding with the transporter protein

6.) add a substance that binds with the serotonin and prevents it from binding with the transporter protein

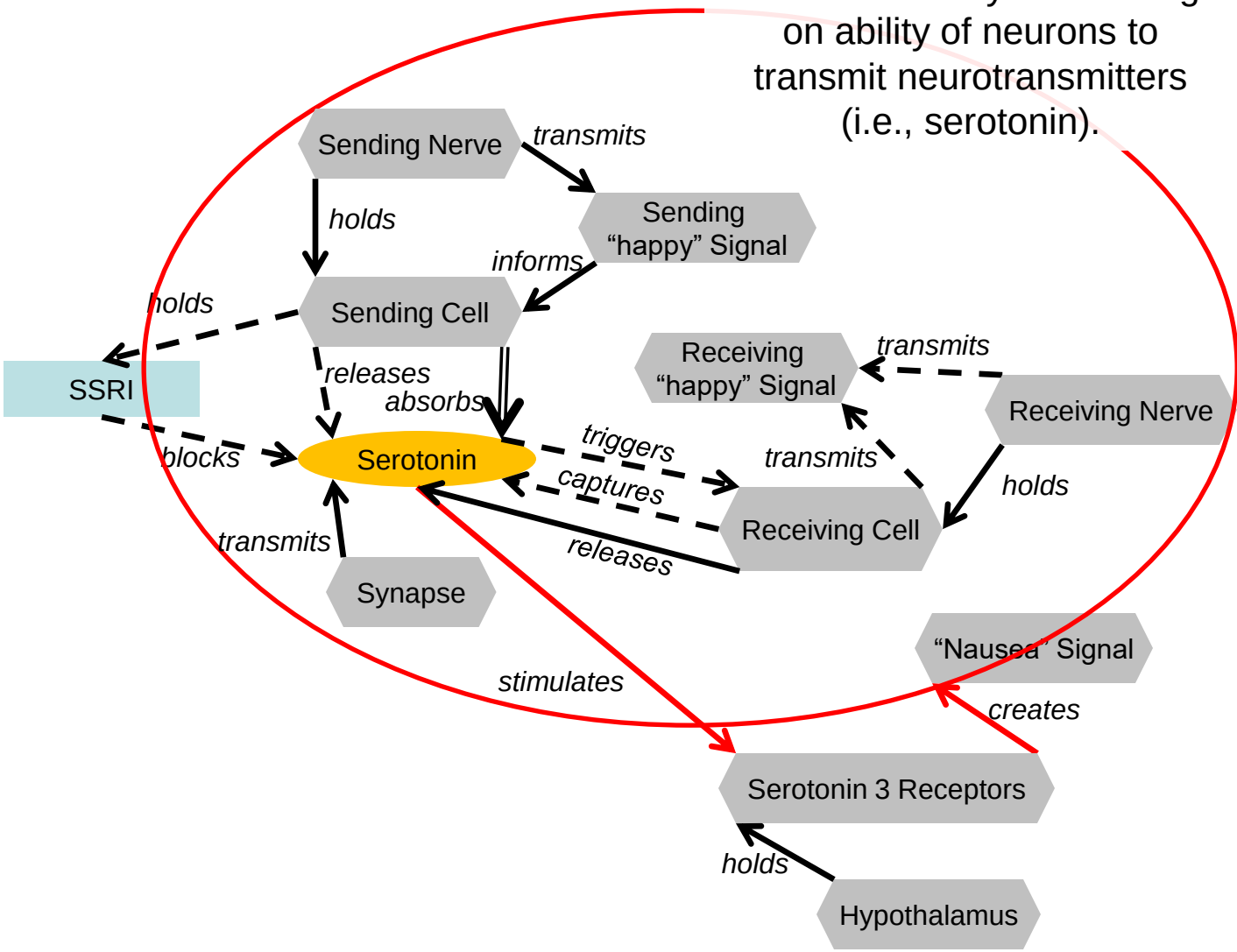






Case Study – Drug Interaction in Body

Next level analysis focusing on ability of neurons to transmit neurotransmitters (i.e., serotonin).



Case Study – Drug Interaction in Body

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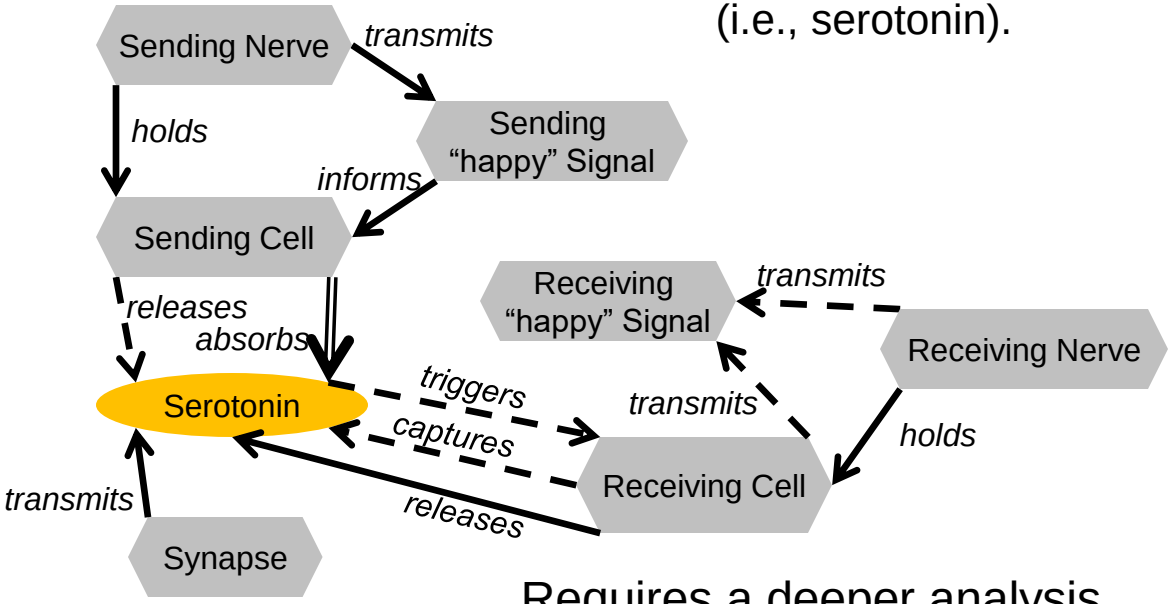
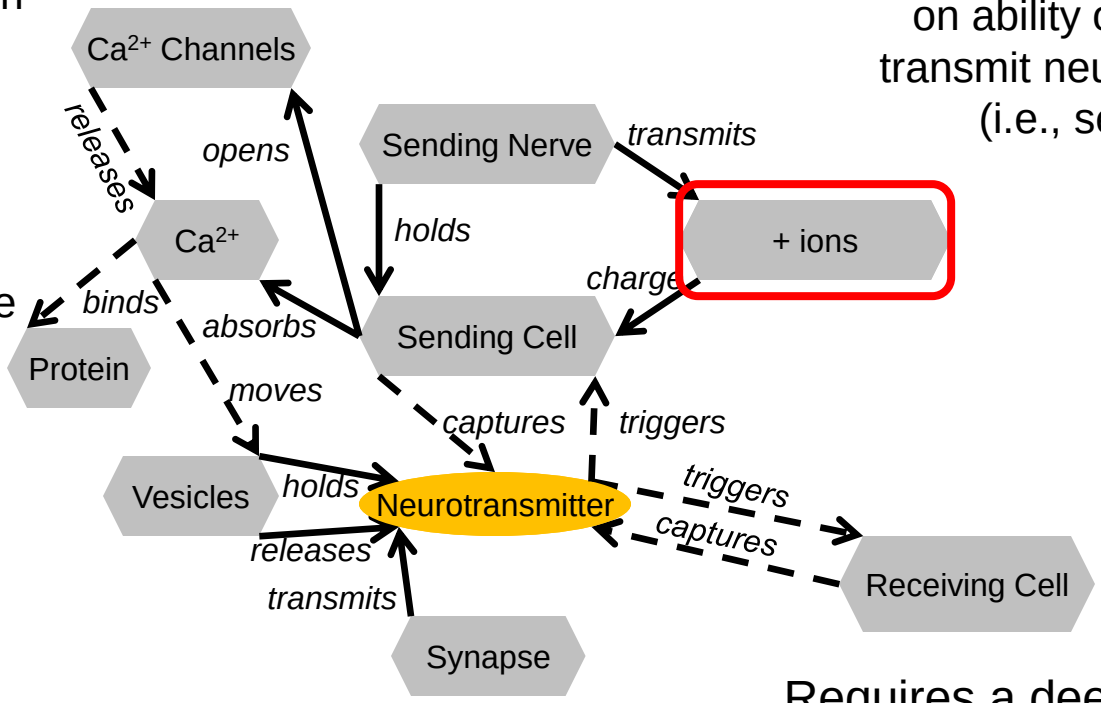


Requires a deeper analysis of how neurons work.

Case Study – Drug Interaction in Body

1.) The action potential signal arrives at the axon terminal.
2.) The local depolarization causes Ca^{2+} channels to open.
3.) Ca^{2+} enters the presynaptic cell because its concentration is greater outside the cell than inside.
4.) The Ca^{2+}, by binding with proteins, causes vesicles filled with neurotransmitter to migrate towards the presynaptic membrane.



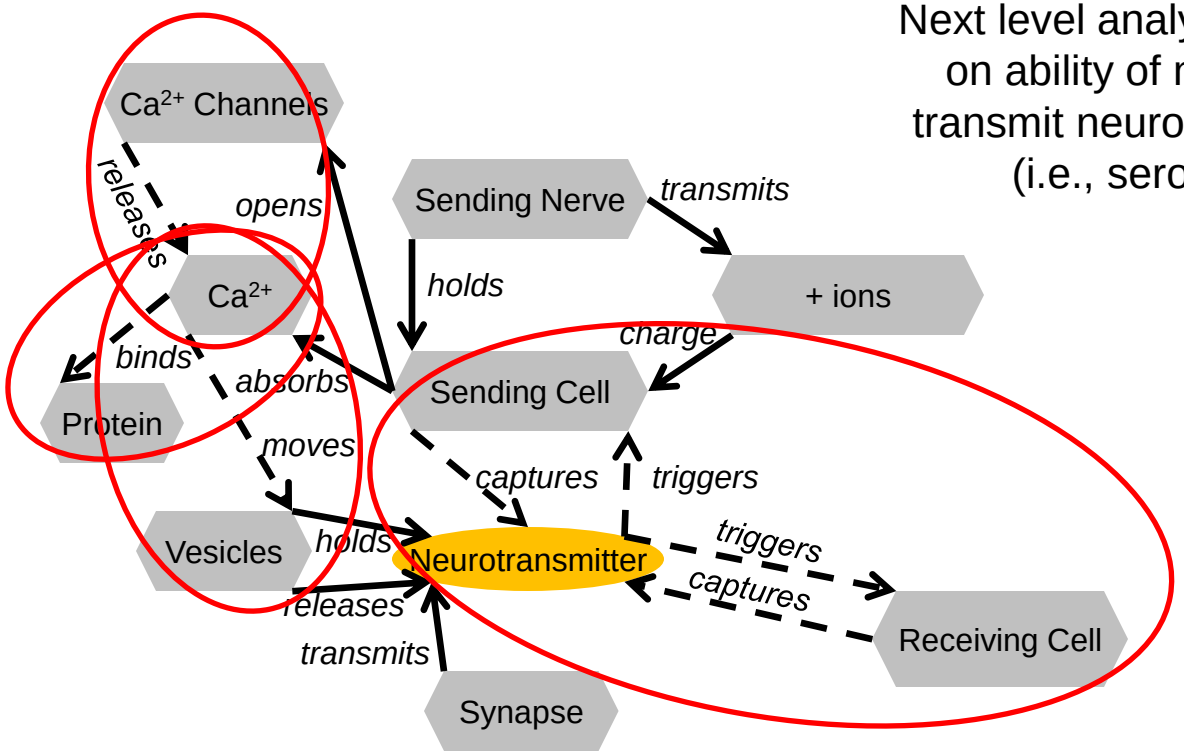
Next level analysis focusing on ability of neurons to transmit neurotransmitters (i.e., serotonin).

Requires a deeper analysis of how neurons work.

5.) The presynaptic membrane and vesicle now forms a continuous membrane, so that the neurotransmitter is released into the synaptic cleft.
6.) The neurotransmitter diffuses through the synaptic cleft and binds with receptor channel membranes that are located in both presynaptic and postsynaptic membranes.

Case Study – Drug Interaction in Body

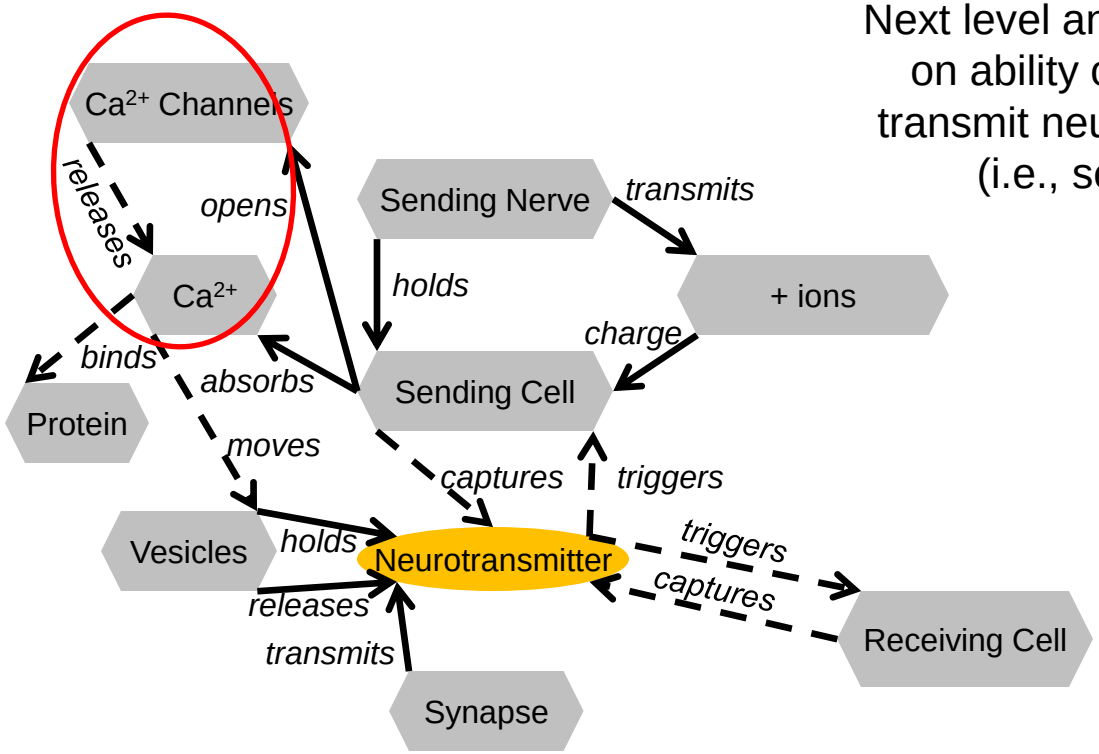
Next level analysis focusing on ability of neurons to transmit neurotransmitters (i.e., serotonin).



Now innovation analysis can be focused on a lower level of neuron function:

1.) how to improve release of Ca^{2+}
2.) how to improve Ca^{2+} and protein binding
3.) how to improve movement of vesicles to membrane wall
4.) how to improve interaction of neurotransmitter

Case Study – Drug Interaction in Body



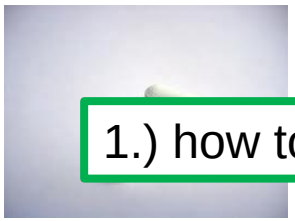
Next level analysis focusing on ability of neurons to transmit neurotransmitters (i.e., serotonin).

Now innovation analysis can be focused on a lower level of neuron function:

1.) how to improve release of Ca^{2+}?

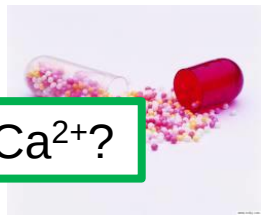
Case Study – Drug Interaction in Body

Example – Drug dynamization and packaging trending



monolith

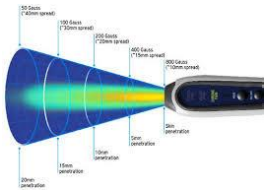
shifted parameter monolith



segmented

liquid

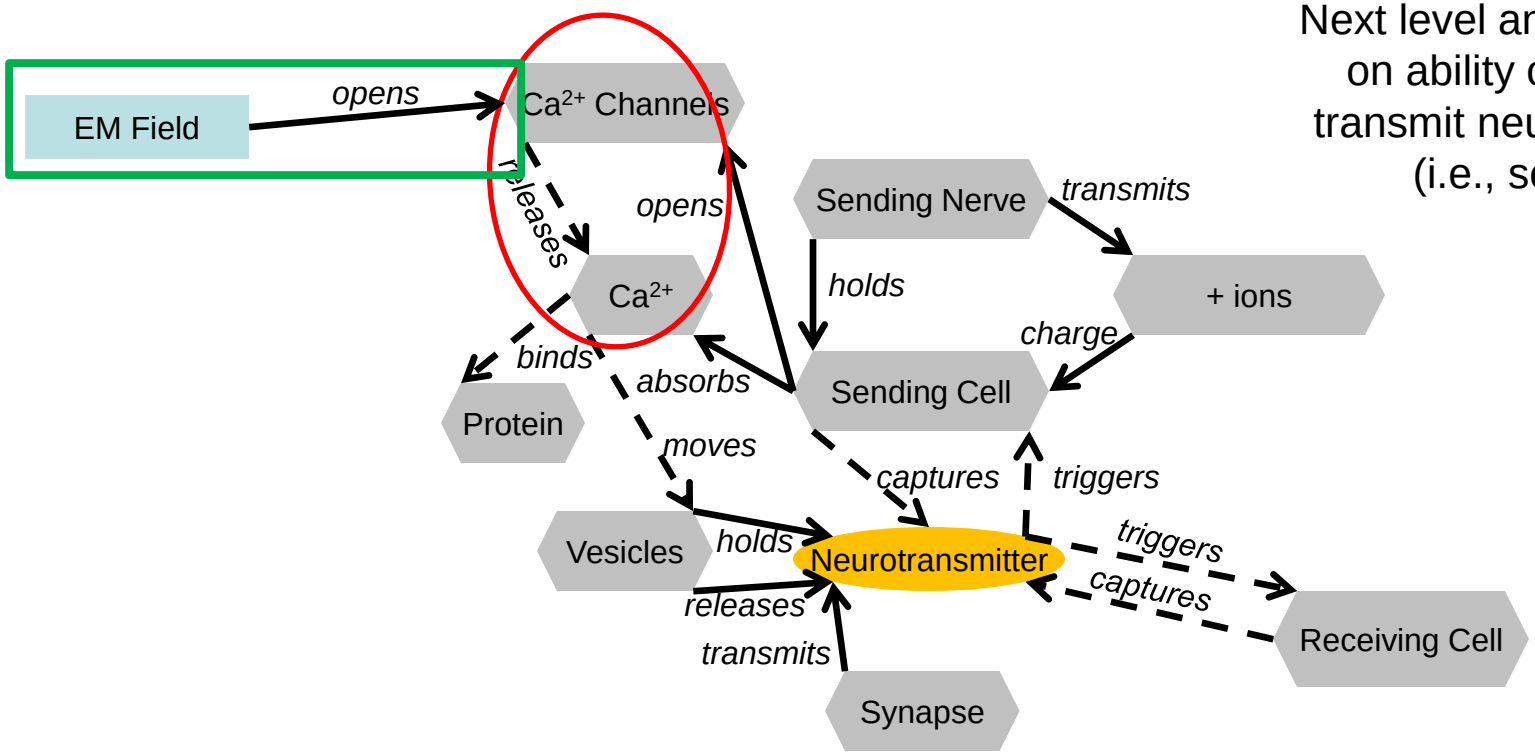
gas



field

1.) how to improve release of Ca^{2+}?

Case Study – Drug Interaction in Body



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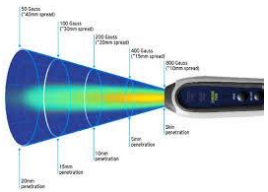


field

Important Take-Aways

- Unlike all other "problem solving" tool kits, TRIZ is the only one with a solution generation engine and that engine is built off of a 75 year study of over 4 million patents.
- TRIZ is exceedingly flexible and can be applied to any and all systems (chemical, biological, political, business, mechanical, electrical, etc.)
- I recently performed (for a Competitive Intelligence conference) a TRIZ analysis of how Artificial Intelligence will affect careers. After the forecasts were made, results were compared with other studies. The parallels were conclusive. TRIZ works!

Thanks and disclaimers

- Thank you to HP for allowing me to share one of their case studies.

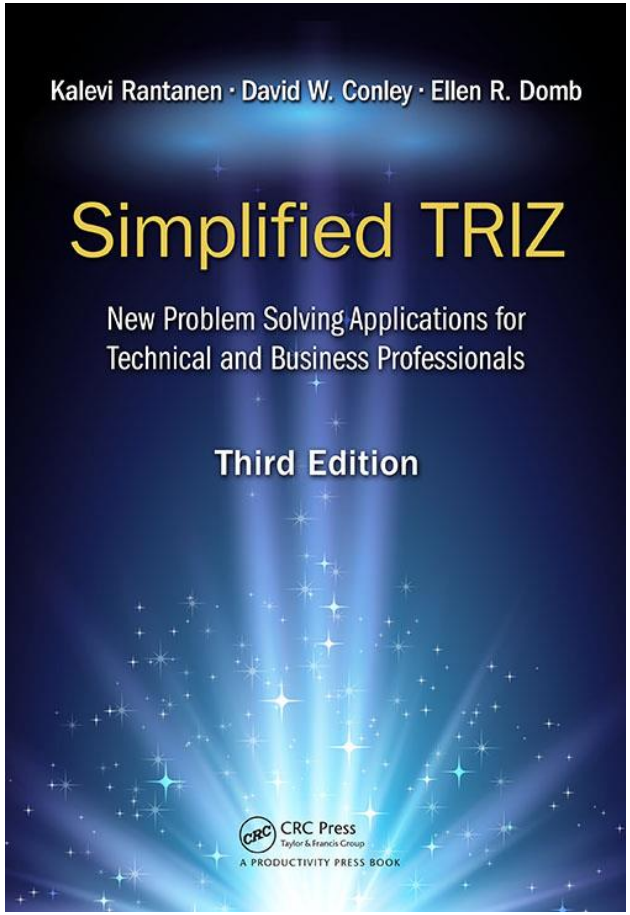
- Permission was given to share the chemical case studies after all propriety inform was removed and if no solution paths were reveled.

- Permission was given to share the pharma (biological/chemical) case study as long as the client was not reveled and if certain solution paths were not reveled.

Shameless Plug

- *Simplified TRIZ: New Problem Solving Applications for Technical and Business Professionals, 3rd Edition*

CRC Press
Taylor & Francis Group



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