

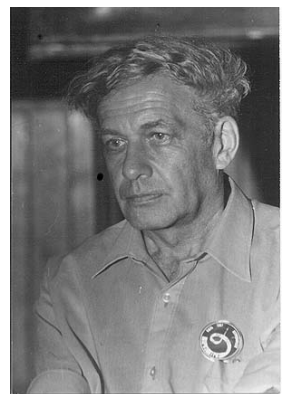
# Advances In The Application of Computational Linguistics for TRIZ Practice

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## TRIZ

- Well defined, systematic approach to inventive problem solving
- Offers a wide selection of concepts & tools
- Provides a framework and language for describing and understanding problems
- Often paired with leading engineering practices
- Global adoption has not been very good



# The TRIZ Information Fund

- Leverage of information is fundamental to TRIZ
- Altschuler's Information fund
  - Scientific knowledge
  - Materials knowledge
  - Industry knowledge
  - Patent information
  - Inventive/creative theory

# Brief History of Computational Linguistics

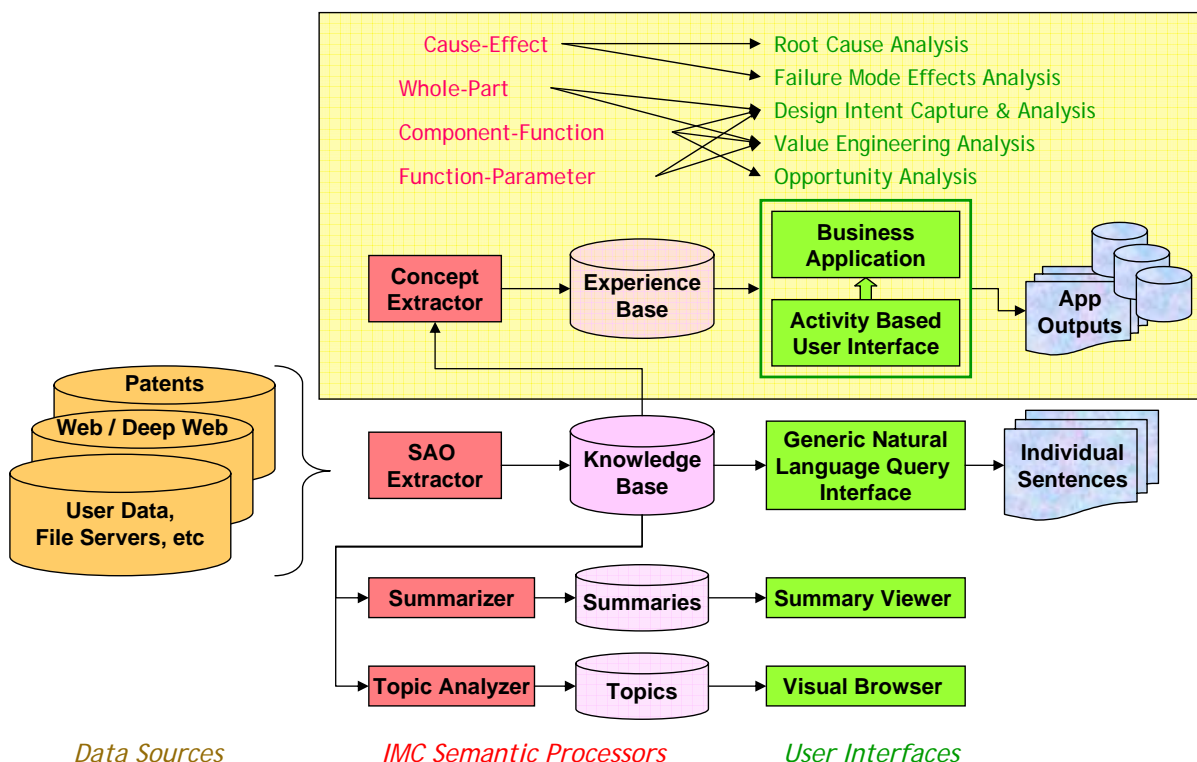
- Born out of the cold war
  - Translate enemy documents
- Conversational response systems
  - ELIZA - 1966
- Systems incorporating world knowledge
  - SHRDLU – 1968-70
- Conceptual Dependency Theory
  - Actor - Action - Object - Direction



# Recent Advances in the State of the Art

- Subject – Action – Object (SAO) model of meaning applied to high precision concept retrieval
- High-level concept extraction
  - Causality (cause~effect)
  - Structure (whole~part)
  - Interaction (components~functions~parameters)
- Intra-lingua semantics

# State of the Art Semantic System



# Computational Linguistics & TRIZ Practice

- TRIZ information fund now a practical reality
- Precision concept retrieval gives greater access to global knowledge
- Contradictional problems addressed with Semantic TRIZ techniques
- High-level concept databases enable faster, more comprehensive problem analysis and solving:
  - Cause~effect
  - Whole~parts
  - Components and functions
  - Functions and parameters

## Case Study



# Biofuel from Marine Algae Via a Mobile Ocean Platform (Ship)

Challenges - How to effectively:

- Move a high-volume of liquid suspension
- Separate particles (algae) from liquid suspension(seawater)
- Dry a biomass

Algae BioFuel gfn - Goldfire Innovator

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## What is known about increasing the growth of algae? And who is doing it?

**DASHBOARD**

**TASK**  
KEI Concept Extractor  
Testor

**Project Description**  
Patents Effects Save Patents Us

Try synonyms: increase maximize augment en  
growth increase increment dev  
algae alga

More general terms: growth development process b  
algae protolict

More specific terms: growth accumulation culture ex  
algae seaweed golden algae vs  
More...

**Most relevant:**

1. An enhanced method and apparatus for driving an immersed flashing light system used for **enhancing algae growth** is disclosed.  
US-5381075 Method and apparatus for driving a flashing light systems using substantially square power pulses  
3 Most relevant and 34 Related result(s) from this document
2. A method for **increasing the rate of growth of algae** over that for wild type algae, comprising contacting algae with an effective amount of a proline selected from the group consisting of 2-hydroxy-5-oxoproline (2-oxoglutaramate) 5-oxoproline (2-pyrrolidone-5-...  
US-6593275 B1 Use of prolines for improving growth and other properties of plants and algae  
2 Most relevant and 71 Related result(s) from this document
3. ...embodiments of the various embodiments of the systems, devices, and methods described herein, the algae utilized may be genetically modified to, for example, increase the oil content of the algae, **increase the 1.8 growth rate of the algae**, change one or more...  
WO-2007070452 A1 SYSTEMS, DEVICES, AND METHODS FOR BIOMASS PRODUCTION  
2 Most relevant and 146 Related result(s) from this document
4. ...the algae dwell near the light for a short period, such as about a fraction of a second, and then pass away from the light, the algae is exposed to a light and dark cycle, which further **enhances growth of the algae**.  
WO-2007134141 A2 APPARATUS AND METHOD FOR GROWING BIOLOGICAL ORGANISMS FOR FUEL AND OTHER PURPOSES  
2 Most relevant and 37 Related result(s) from this document
5. ...the algae dwell near the light for a short period, such as about a fraction of a second, and then pass away

**Most relevant:**  
alga growth (59)  
increase of... (12)  
rate of growth... (10)  
growth of... (4)  
inhibiting alga... (3)  
preventing of... (2)  
level of alga... (2)  
excessive... (2)  
growth of barnacle (2)  
control of... (1)  
growth of... (1)  
growth of alga... (1)  
undesirable... (1)  
growth of... (1)  
rapid growth of... (1)

Project Explorer Save Solution(s)... Export... Researcher Patent Collections

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# Knowledge Enabled System Functional Modeling & Analysis

Harvest 2\* - Goldfire Innovator : Innovator Workbench

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## Mobile System to Collect & Process Algae

**DASHBOARD**

**TASK**  
Improve Existing System

**PROJECT DESCRIPTION**

**MODEL & IMPROVE SYSTEM**

**Build Device Model**

Simplify Design  
Solve in Solution Manager

Diagram showing functional components: Dried Pulp, Processor, Unrefined Oil, Transport device, Algae, Gathering device, Separation device, Waves, gas, seawater.

**Function Search for component**

Component: Unrefined Oil

which gets on:  
which receives the action of:

Actions: extract, control discharge, increase pressure, etc.

Parameters: viscosity, weight, quantity, etc.

**Find Components in Knowledge Bases and in the Repository**

Device: marine alga biofuel

Element Name	Arranged:	By frequency	Ref.	Found in Device
acid				marine alga; marine micro alga; ma
chlorophyll				alga; red alga; green alga; blue-gr
mineral				marine alga; alga; sea alga; blue-g
phycocyanin				marine alga; alga
transgene				marine alga; transgenic alga; trans
alga				micro alga; alga; green alga Haem
sulfate				marine alga; alga; red alga; brown
substance				marine alga; alga; red alga
alginate				marine brown alga; alga; brown al
plant				alga

- Automatically suggests parts & their functional interactions from internal & external knowledge
- Guides exploration of innovative, alternative configurations to perform required functions
- Provides a common language to capture, communicate & reuse design rationale & intents

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# Knowledge Enabled Root Cause Analysis

The screenshot shows the InventionMachine software interface. On the left is a dashboard with a task list including 'KEI Concept Extractor Testor', 'Project Description', 'Researcher', 'Root-Cause Analysis', 'Build Cause-Effect Model', and 'Identify Core Problems'. The main workspace displays a causal model with nodes: 'insufficient heat exchange area', 'temperature too low', 'moisture trapped in gas', 'squeezing not sufficient', 'inadequate ventilation', and 'excessive moisture in biomass'. A 'Cause Finder' window is open on the right, showing a search for causes matching the effect 'inadequate ventilation'. The search results list various causes from knowledge bases, with 'ventilation problem', 'temperature', and 'perspiration' checked. A red dashed arrow points from the 'Cause Finder' window to the 'excessive moisture in biomass' node in the model.

- Automatically suggests potential causes from internal & external knowledge sources
- Guides analysis of core or “root cause” problems
- Launches queries to discover solutions
- Results in faster time-to-resolution and 1<sup>st</sup>-time-fix
- Captures expertise & documents analysis for audit and future reuse

# Patterns of System Modification

The screenshot shows the InventionMachine software interface with a system modification pattern. The main workspace displays a process flow: 'moisture' -> 'drying' -> 'biomass'. A red circle highlights this flow. Below the flow are several modification options: 'Monolith', 'Segmented monolith', 'Liquid, powder', 'Gas, plasma', and 'Field'. An example of 'Molding paste' is shown, comparing an 'Old design' (powder in a mold) with a 'New design' (powder containing a plastic component). The text explains that the new design improves the action of drying by segmenting moisture or biomass into two or more parts, into a powder, into a liquid, etc. A red box highlights the text: 'It is proposed to add a plastic evaporating component into the powder.' Below this, it states: 'The resulting paste effectively fills the mold while the plastic component evaporates during heating. The molding paste increases the quality of filter elements.'

- Technology evolves along certain predictable trends or patterns. TRIZ Patterns of System Modification stimulate creative thinking & inventive problem, suggesting new approaches to perform a function, or future directions that a process can take base on Standard Solutions.

Untitled\* - Goldfire Innovator

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InventionMachine™

## What is known about separating algae from water? And who is doing it?

**DASHBOARD**

**TASK**  
KEI Concept Extractor  
Testor

**Project Description**

**Researcher**

**Knowledge Search**

Patent Collections

IMC Scientific Effects

Inventive Principles

System Modification Patterns

Solution Manager

**Root-Cause Analysis**

**Device Analysis**

Project Explorer

Save Solution(s)... Export...

Researcher Patent Collections

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InventionMachine™

how to separate algae from water

Your query was processed as a **Natural Language** e...  
[Click here](#) to perform a fielded search in Patent Collection

**Patents** Personal Effects

Try synonyms: **separate** extract extricate fract...

More general terms: **algae** alga

More specific terms: **water** water supply water system  
**algae** installation excretion binary compound element entity numerical oxide liquid  
**water** seaweed golden algae yellow-green algae diatom confervoid algae brown algae euceloid green algae chlorella  
[More...](#)

**Most relevant:**

- Since the materials within the chamber 54 are primarily **water** and **algae**, the discharge in the conduit 58 can be taken into a centrifuge 59 effective to **separate** the **algae from the water** and discharge the algae through a line 61 for use...  
[US-3951805](#) Algae harvester  
2 Most relevant and 92 Related result(s) from this document
- The coalesced **algae** and other material is preferably **separated from** the treated **water** by sparging air through the treated water held in a treating vessel to float the material with removal thereof 60 by skimming, maintaining a slight overflow over a weir at...  
[US-3836460](#) PROCESS FOR REMOVAL OF ALGAE, DIATOMS AND ORGANIC CONTAMINANTS FROM WATER  
2 Most relevant and 47 Related result(s) from this document
- Because it is difficult to apply the method using filtering or centrifuging to the industrial process even though solid **algae** can be **separated from** liquid purification **water** by filtering or centrifuging in the laboratory.  
[US-6989102 B1](#) Alginate gel based adsorbents for heavy metal removal  
2 Most relevant and 66 Related result(s) from this document
- Harvested **algae** is **separated from** the **water** by the gentle action of the wedgewire screen which may be oriented across the bottom edge of the growth surface or oriented within the stream of a collecting trough.  
[US-5715774](#) Animal feedstocks comprising harvested algal turf and a method of preparing and using the same  
2 Most relevant and 101 Related result(s) from this document
- Microscreens were developed for **separating algae**, clay sand and sand **from water** before sand filtering.

**Most relevant:**

- water (12)
- alga (12)
- lake water (4)
- treated water (2)
- Harvested alga (2)
- alga culture (1)
- contaminated water (1)
- alga associated... (1)
- water flowing (1)
- cultivated... (1)
- raw water (1)
- green alga (1)
- suspended alga (1)
- floating alga (1)
- liquid... (1)

## Conclusions

- Computation linguistics & Semantic Analysis has evolved to a new stage
- New applications of semantic analysis enable better problem analysis and solving
  - Makes Altschuler's vision of the Information Fund a practical reality
  - Provides practitioners greater access to actionable knowledge
  - Knowledge Enablement technology helps make TRIZ available to a broader pool of practitioners

Questions?

**Thank You!**