



Generative Inventions

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Software that invents. Some history

- ◆ 1983. Pulsar AI-software: used pure math to create novel methods for signal detection in space. Non-TRIZ
- ◆ 1987-1991: AI Lab, Invention Machine Lab, Minsk, Saint Petersburg. TRIZ-based software
- ◆ 1991-2001: Invention Machine Corp., Boston. TRIZ-based software and semantic engines

Generative Inventions is a step forward from previous AI projects

Note: from 2002 the author has no relation with Invention Machine Corp.



Generative Inventions. Functionality

- ◆ Discovers new needs
- ◆ Creates novel technical and socio-technical ideas
- ◆ Helps human users to accept most promising ideas

AI system works in non-stop mode



Three popular questions

◆ Can computer invent?

- Computer is able to process any algorithm: A.Turing 1936
- Practical prove: TechOptimizer in 1997 by Invention Machine Corp.

◆ Do we need creative software?

- Yes, because it increases productivity of engineers and inventors

◆ Will creative A.I. replace human inventors?

- No, it will not. At least for our life span.
A.I. makes human users more creative, it *intensifies* human creativity

Principal problems of TRIZ

- ◆ Problem #4: Complexity

Valeri Souchkov. TRIZ IN THE WORLD: HISTORY, CURRENT STATUS, AND ISSUES OF CONCERN, 2016

- ◆ Uncertainty, advises are too abstract

“you may solve your overheating problem by *chain substance-field model*” ... - *What ?!*

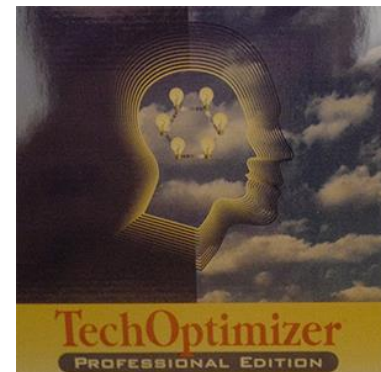
- ◆ Lack of relevant knowledge Here and Now

Problems of complexity and lack of relevant knowledge
can be solved by intelligent software tools

TRIZ-based software since 1989. Lessons learned

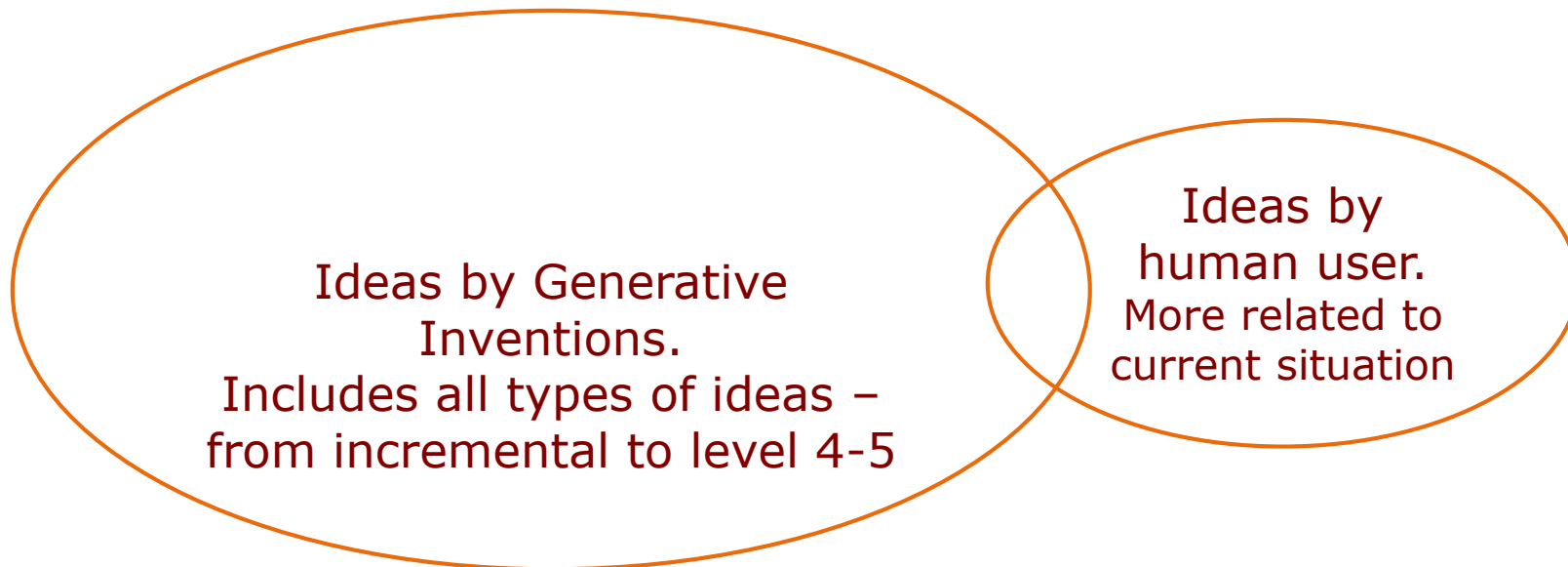
- ◆ Greatly intensifies creativity of *some* human users
 - Glucose detection case
 - GE training course at UCONN
- ◆ Majority of promising ideas rejected by users
- ◆ Usage is rare, except semantic knowledge engines

TRIZ-based software played a *supportive* role



Generative Inventions. AI as creative partner

- ◆ AI software matches needs with technology shells and scientific effects, *invents* novel ideas, builds large data base of conceptual ideas
- ◆ Human users find promising ideas in the database, refine them, formulate and solve related problems together with A.I., make decision on implementation of ideas

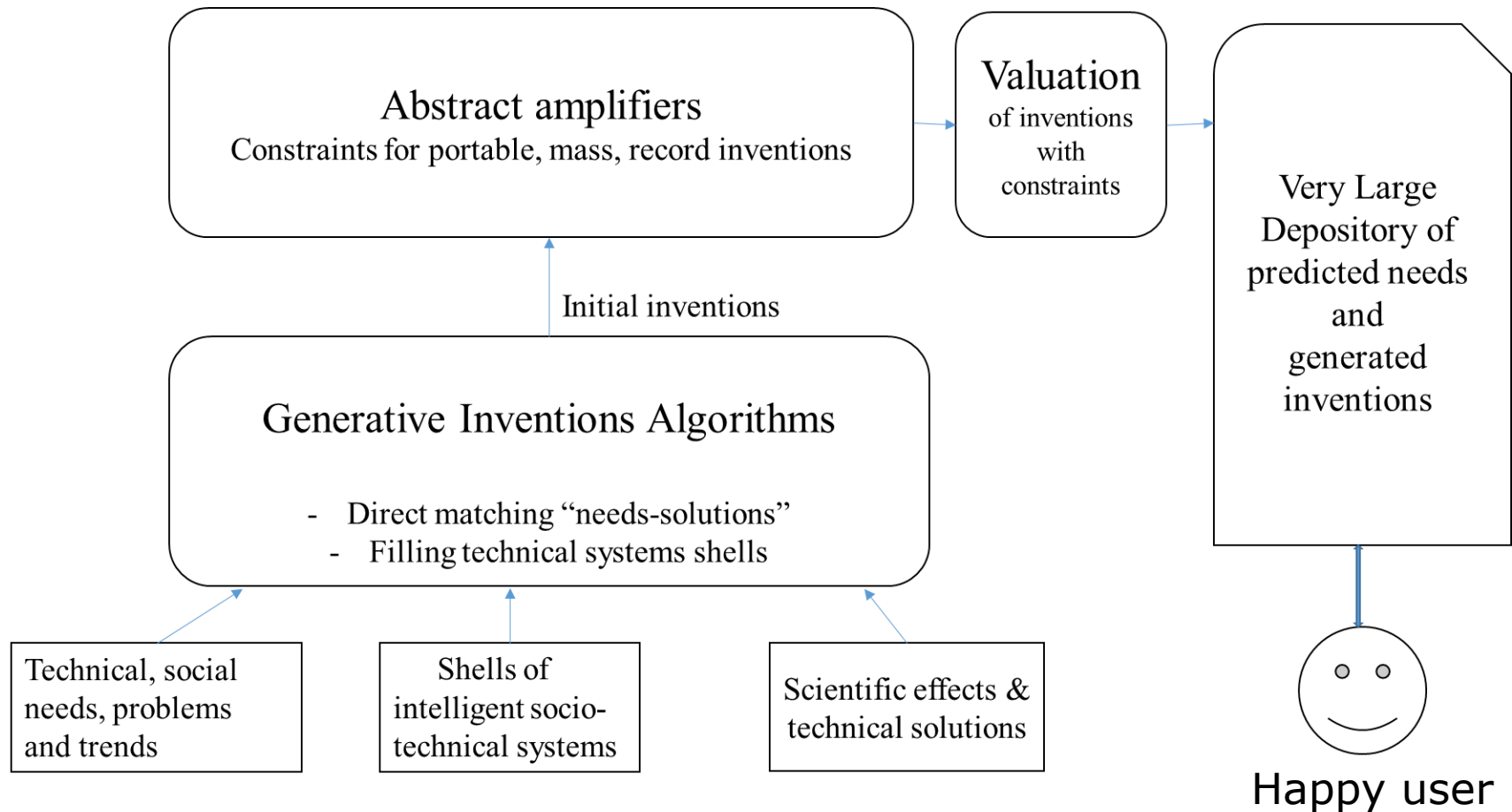


Generative Inventions. Main features

- ◆ *Synthesizes* inventive ideas with estimation of parameters
- ◆ Shows how to amplify parameters and solve problems
- ◆ Helps user to accept novel ideas by providing:
 - Info on suppliers, R&D groups and experts
 - Stories about novel concepts
- ◆ Looks for new effects, uses novelty propagation to create new ideas immediately after effects were published

We need technology shells and novelty propagation

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Architecture of A.I. System for Generative Inventions

Technology shell for microchips overheating problem

Power density greater than in rocket nozzle

Subject → Action → Object

Microchips → Generate → Heat

Create microchips with very low or zero heat

- First graphene transistor July 5, 2017 Sweden
- Single electron transistor
- Casimir effect

Subject - cools – microchips

- Carbon nanotubes
- Micro channels with water
- Kinetic cooling
- Ions drag air
- Evaporating: Fujitsu phones
- Ferroelectric polymers
- EHP-electrowetting heat pipes
- Electroosmotic pump
- Ferromagnetic liquid
- Liquid metal cools chips

Heat but no damage

- Warms up office
- Approximate computing
- Notebook cooks eggs



Technology shell: parameters, validation, amplifiers

Conceptual idea: carbon nanotubes – cool – microchips

Parameters: thermal conductivity of carbon nanotubes is *several times* better than cooper.

Problem: weak interaction between carbon and metal of chip impacts heat flow

Solution: organic molecules (aminopropyl-trialkoxo-silane (APS) and cysteamine) create strong covalent bonds between carbon nanotubes and metal of microchips

Parameters of problem solution: *six-fold* improvement in the heat flow between metal and carbon nanotubes

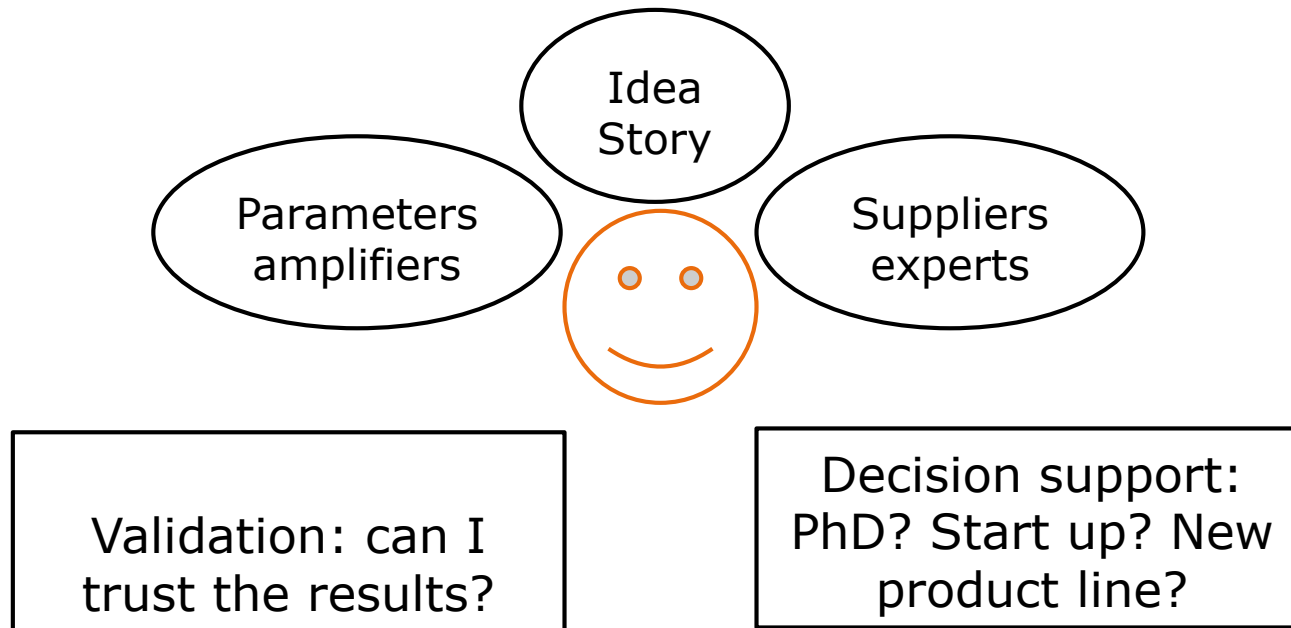
Validation of research: group of physicist with the *Lawrence Berkeley* National Laboratory's Materials Sciences Division and two former *Intel* researchers [8]

Practical use: not found. Suppliers of technology: not found. Experts [8]

Amplifiers of main parameter: adaptive heat management, new molecules

Summary: positive validation of the idea is based on results of experiments: six-fold improvement in the heat flow, which is very good, and high reputation of Lawrence Berkeley Lab.

Relevant knowledge to avoid rejection of idea



Technology shells bring all relevant knowledge to end user
This knowledge help the user to understand and accept idea

Novelty propagation for new effect

- ◆ Laser Streaming: Turning a Laser Beam into a Flow of Liquid by Yanan Wang and team of 12 researchers from Harvard Univ, Univ. of Electronic Science and Technology of China, <https://arxiv.org/abs/1708.05852> Cornell University Library, submitted on August 19, 2017
“Here we report the discovery of a new *optofluidics* principle and demonstrate the generation of a steady-state water flow by a pulsed laser beam through a glass window”:

Pulsed laser → moves → water (liquid)

Water → cools → microchips

Liquid metal → cools → microchips

Liquid nitrogen → cools → microchips

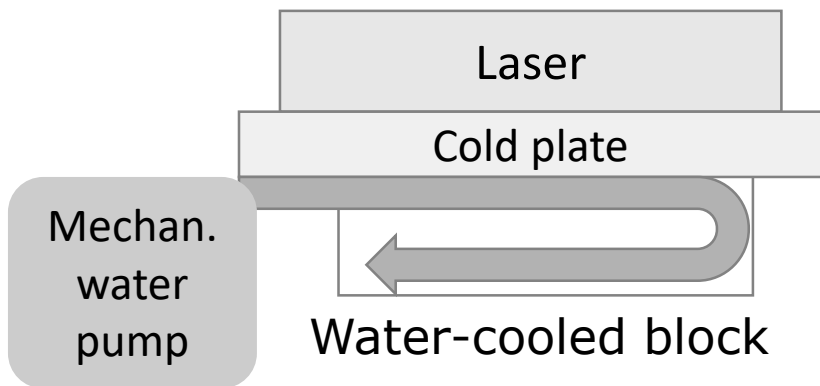
AI system adds three novel concepts, in all of them mechanical pump is replaced by pulsed laser

Novelty propagation for new effect. Use of resource

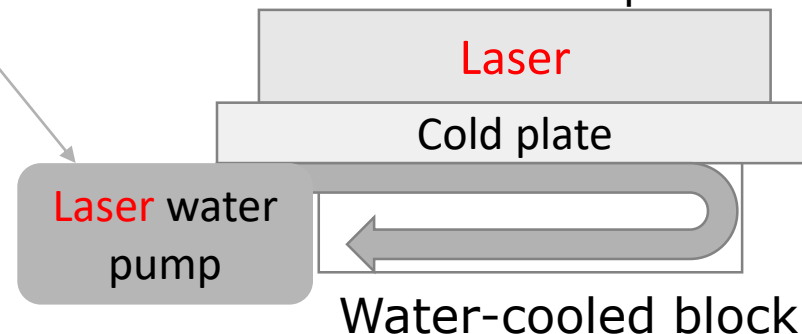
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“Here we report the discovery of a new *optofluidics* principle and demonstrate the generation of a steady-state water flow by a pulsed laser beam through a glass window”:

Pulsed laser → moves → water

Old design:
mechanical pump → moves → water



Novel idea: laser → moves → water
No mechanical parts



With novelty propagation this idea
could be created on Aug 19, 2017

More new effects and novelty propagation

- ◆ Observation of broadband *terahertz* wave generation from *liquid water*. By Qi Jin et al. **Aug 14, 2017**. <https://phys.org/news/2017-08-thought-impossible-scientists-liquid-thz.html>

Known methods: (solid crystals, metals, gas plasma) → generate → terahertz waves

New discovery: **Liquid water** → generates → terahertz waves

Novel ideas will be automatically created by applying

Subject (liquid water) to *generate, detect, control* terahertz waves

- ◆ Sympathetic laser-cooling of graphene with *Casimir-Polder* forces. By Sofia Ribeiro, Hugo Terças, **13 Jul 2016**. <https://arxiv.org/abs/1607.03782>. The atoms couple to the graphene membrane via Casimir-Polder forces. We are able to cool a graphene sheet down to ~ **60 microkelvin**.

Novelty propagation algorithm will find all technology shells with low temperature as important feature and will create novel ideas with Casimir effect

Benefits of Generative Inventions

- ◆ Active corporate knowledge base for main functions
- ◆ New effect or material discovered, knowledge base is immediately updated:
 - Novel ideas are generated automatically
 - Validation information is provided
 - Parameters are estimated
 - Problems and potential solutions listed
- ◆ End result: knowledge workers (inventors, engineers, researchers) become much more productive