

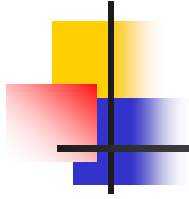


Design by analogy: Achieving more patentable ideas from one creative design

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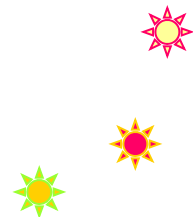
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1 Introduction



◆ What is a patent?

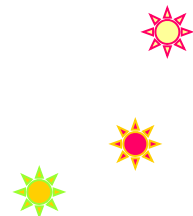
- A form of intellectual property
- A set of exclusive rights granted by a sovereign state
- An inventor or assignee for a limited period of time
- In exchange for detailed public disclosure of an **invention**
- A solution to a specific technological problem and is a product or a process

◆ Why patent application?

- Provide incentives for economically efficient research and development
- Intended to facilitate and encourage disclosure of innovations into the public domain for the common good
- Improve the product and Enhance its quality
- Reflection of strength of the enterprise, intangible assets and advertisement

◆ Characteristics?

- Novelty, new and not known
- Usefulness, be manufactured or used
- Non-obviousness, sufficiently different from the state of the art



1 Introduction



◆ Ideation techniques?

➤ Intuitive method

- result is unpredictable
- possible to obtain innovative concepts

Brainstorming(group ideation technique), 635 methods, C-sketch (based on brainstorming), Synectics

.....

➤ Logical method

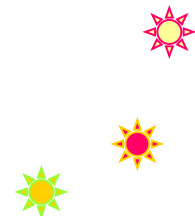
- problem decomposition and analysis systematically
- based on scientific principles

Design catalogs (catalogued in database), TRIZ (theory of inventive problem solving)

.....

➤ Patentable idea generation

- patent circumvention
- some tools in TRIZ, such as evolution tree、trimming



1 Introduction



◆ Design by analogy (Analogy based design)

➤ What is analogy?

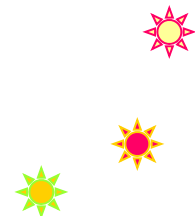
-In ancient Greek the word *αναλογία* (*analogia*) originally meant proportionality, in the mathematical sense.

-Greek philosopher, such as Plato and Aristotle

Analogous objects did not share necessarily a **relation**, but also a **pattern**, a **regularity**, an **attribute**, an **effect** et al.

-Cognitive psychology

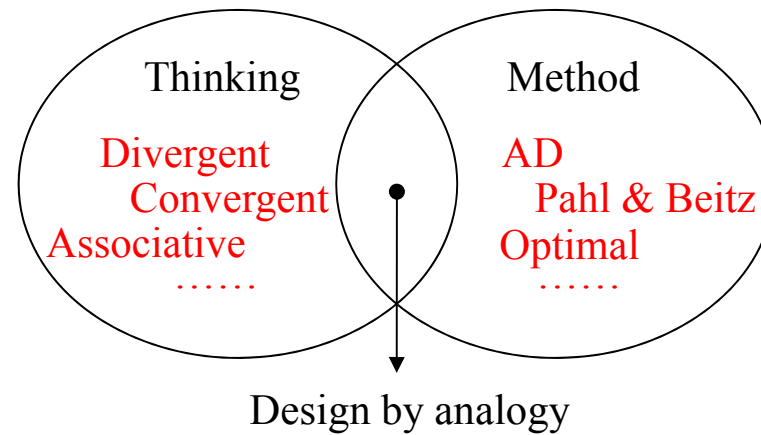
Analogy depends on the mapping or alignment of the elements of source and target. The mapping takes place not only between objects, but also between relations of objects and between situations.



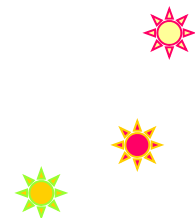
1 Introduction



◆ Design by analogy (Analogy based design)



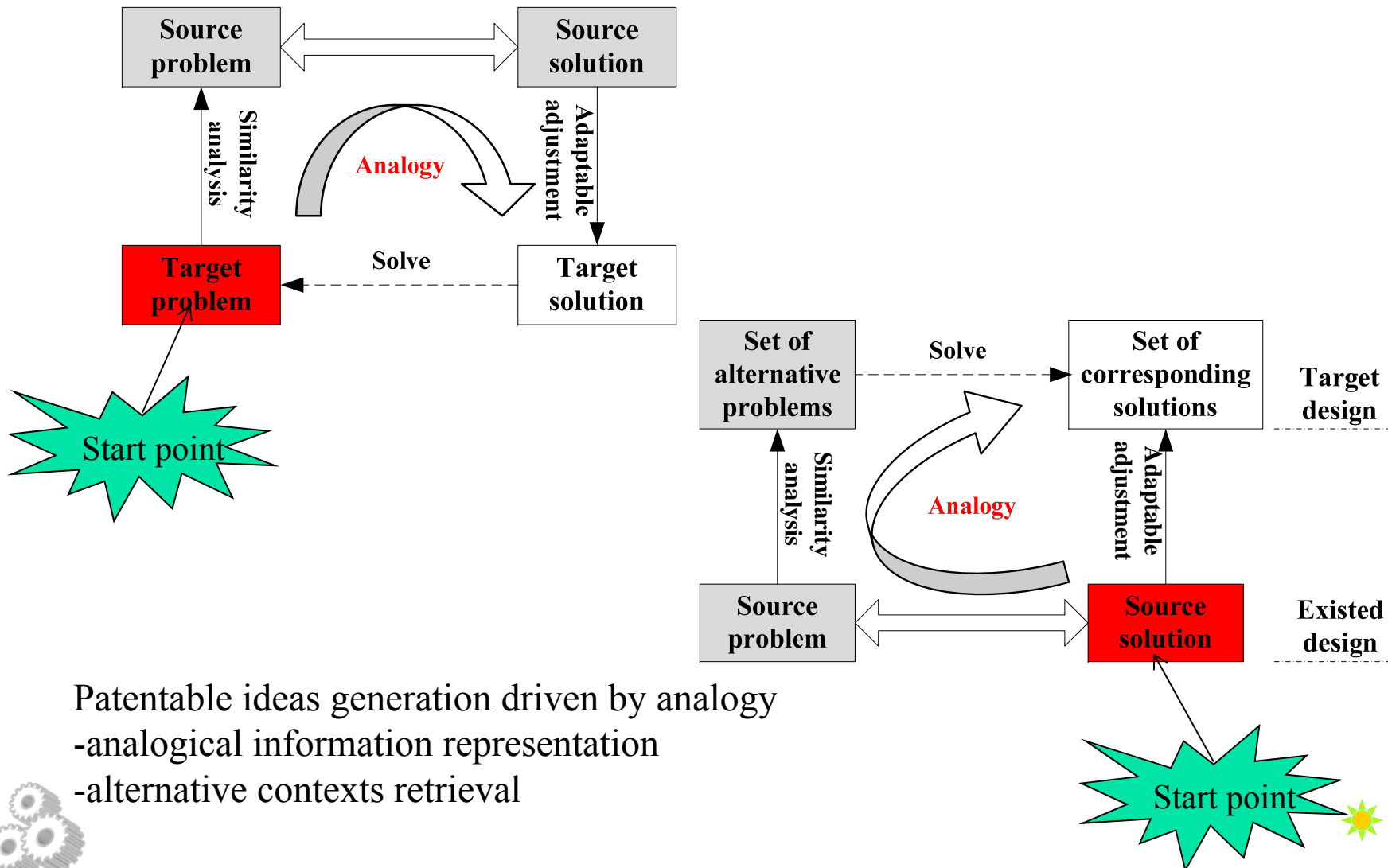
- Achievement from the field of cognitive psychology
- Particular characteristics from the field of engineering design
- Supportive tools



1 Introduction



◆ Design by analogy (Analogy based design)



Patentable ideas generation driven by analogy
-analogical information representation
-alternative contexts retrieval



2 Analogical information representation



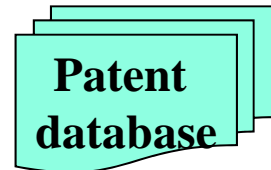
◆ What?

According to Gero's FBS Theory, design is represented as the mapping between function, behavior and structure.

- Function is the design intentions or purposes
- Behavior is attributed from how the structure of an artifact achieves its functions
- Structure is the components which make up an artifact and their relationships

◆ Where?

Patent database is a huge knowledge source where 80% of technical information is not available in the non-patent literature.

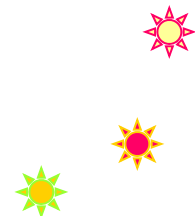


◆ How?

Patent document

- Creative technical subject
- The constituents of a composition or mixture, or components of a process or structure, or applications of classified technical subjects.

To classify relevant technical information and retrieve them easily, the **International Patent Classification (IPC)** is established.



2 Analogical information representation



◆ How?

Based on the research of Ji, retrieved the function, effect and structure knowledge from the titles of IPC, we reclassified them into function, behavior and structure.

➤ Function information reflects what the design work for from the perspective of technical system, not the environment or person.

F15B11/04 for controlling the speed

F04B53/08 cooling (of machines or engines in general F01P); Heating;
Preventing freezing

operational verb / operational verb + noun

➤ Behavior describes the working process of the technical system, showing how the function is delivered. It is composed of working effect and (or) phenomenon.

F21L 13/08 by reciprocating pusher actuated by hand

F21V14/02 by movement of light sources

F25B9/04 using vortex effect

F42B22/04 influenced mines, e.g. by magnetic or acoustic effect



2 Analogical information representation

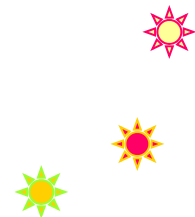


◆ How?

➤ Structure is the components which make up an artifact and their relationships.

F03D1/06 rotors

F04C19/00 rotary-piston pumps with fluid ring or the like, specially adapted for elastic fluids





3 Alternative problems retrieval



◆ Heuristics to find the alternative contexts where the source design could be transferred

➤ Search alternative targets driven by function information

-analogy source: cleaning electronic component with ultrasonic

-analysis of source: it can be used to remove dirty, clean complex structures

-analogical information representation: clean dirty

-alternative contexts: washing machine, dishwasher, toothbrush

➤ Search alternative targets driven by behavior information

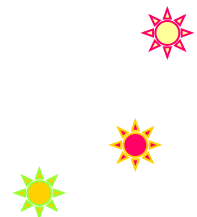
-analogy source: automatic washing machine

-analysis of source: human → human + tool → human + powered tool →

human + semi-automated tool → human + automated tool → automated tool

-analogical information representation: reduces human involvement

-alternative contexts: coffee machine, soybean milk machine, camera, even the self-learning software system





3 Alternative problems retrieval



◆ Heuristics to find the alternative contexts where the source design could be transferred

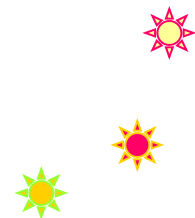
➤ Search alternative targets driven by structure information

-analogy source: inverter air conditioner

-analysis of source: apply variable-frequency drive into air conditioner for energy consuming

-analogical information representation: variable-frequency interacts with compressor

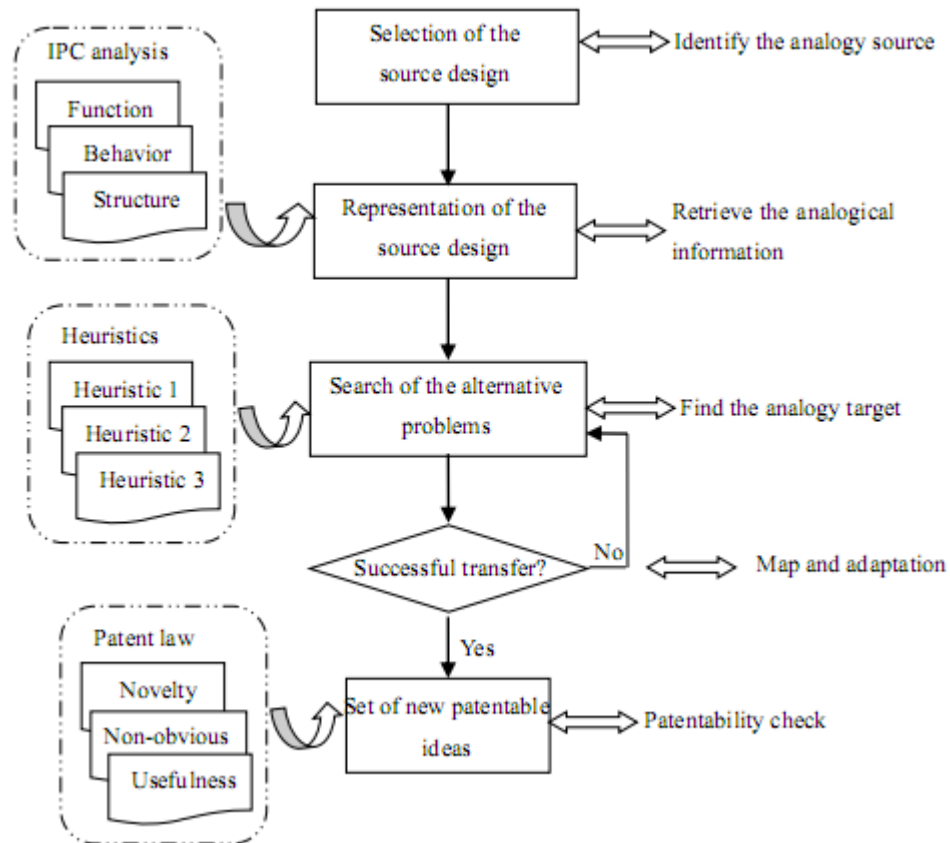
-alternative contexts: refrigerator



4 Case study

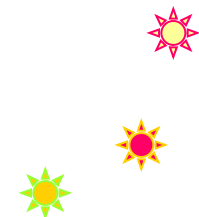


◆ Patentable ideation process model



- Step 1: select one creative design as analogy source
- Step 2: representation of the analogy source
- Step 3: search of the alternative problems
- Step 4: transfer of the ideas
- Step 5: set of new patentable ideas

Fig 1 Patentable ideas generation model



4 Case study



◆ Case

➤ Step 1: Selection



Fig 2a Bladeless fan

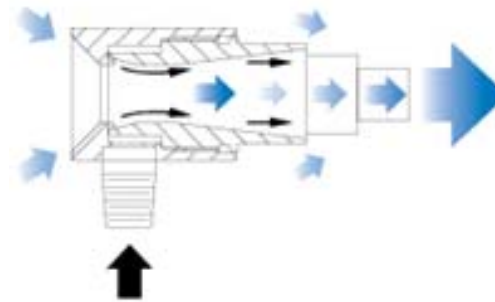
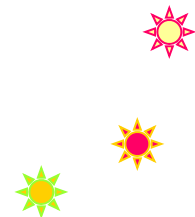


Fig 2b Air Multiplier

The working principle of the bladeless fan is that the air is drawn in by a fan in the base and then directed up into a ring, finally comes out from the crack, without external blades.



4 Case study



◆ Case

➤ Step 2: Representation

Field Command Bulk Semantic Expand Classification Legal

<<Back to simple Top IPC

Preview Search C

Display numbers

TAC:(bladeless fa

F04F5/16 ... displacing elastic fluids [1,2006.01]: 156	F04F5/44 ... Component parts, details, or accessories not provided for in, or of interest apart from, groups F04F 5/02-F04F 5/42 [1,2006.01]: 113	F04B41/06 ... Combinations of two moving pumps [1,2006.01]: 55	F24F11/02 ... Arrange... or mounting of control or safety devices [1,2006... 30
Ventilating	Cooling	Separating	Moving
Flow of liquids or gases	Selective separation	Behavior information - phenomenon	
F04D25/08 ... the working fluid being air, e.g. for ventilation [1,2006.01]: 121	F04F5/46 ... Arrangements of	F04D27/00 ... Control, e.g. regulation, of pumps, pumping installations or	F04D29/40 ... Casings; Connections for working fluid [1,2006.01]:
Tendency of a jet of fluid emerging from an orifice to follow an adjacent flat or curved surface and to entrain fluid from the surroundings		F04D29/66 ... Combating cavitation, whirls, noise, vibration, or the like (gas-	F24F5/00 Air-conditioning systems or apparatus not covered by

Function information

Behavior information - effect

Structure information - sub/super system

Structure information - key characteristics/relation

Pump	Motors	Manufacture, metallurgical, digital information industry	
Annular chamber	Crack	Inlet	Outlet



4 Case study



◆ Case

➤ Step 3: Alternative context retrieval and patentable ideas generation

Heuristic 1

Taking “moving” and “separating” “moving substances” as analogical stimuli.

Map the idea into the modified design of medlar picking machine, to separate the medlar from the tree.

Specifically, one of the inlets provided the compressed air, another one was used for sucking medlar and the outlet was for blowing the surrounding leaves of the medlar to avoid the blocking problem.

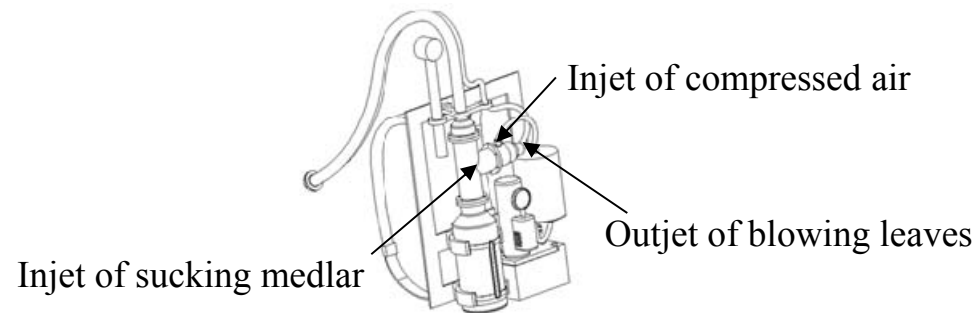
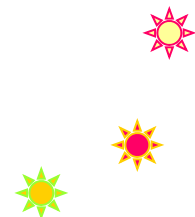


Fig 3a New design of medlar picking machine



4 Case study



◆ Case

Heuristic 2

Taking one of the phenomenon, “selective separation”, as analogical stimuli, Mapping the idea into the design of the winnowing equipment in the harvester. The fluid-guiding plate was designed for directing and separating the air flow.

Heuristic 3

Using one of the sub/super-system structure information, motors, as the alternative system

Students tried to apply the source design to improve the efficiency of heat dissipation. The key structure characteristics, “Annular chamber”, “crack”, “inlet” and “outlet” of bladeless fan, were transferred and mapped to cool both the inside and outside of the motor.

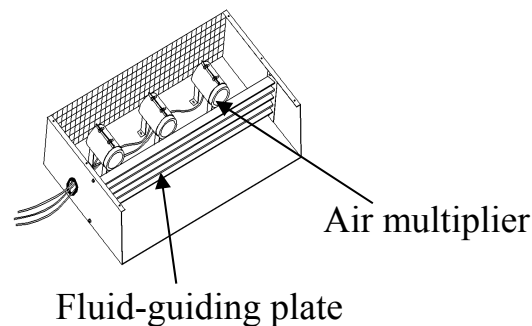


Fig 3b New design of winnowing equipment

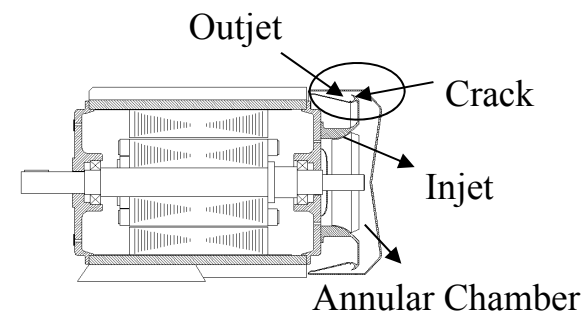


Fig 3c New design of cooling electric motor structure

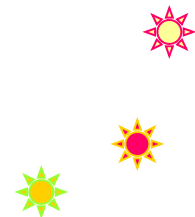


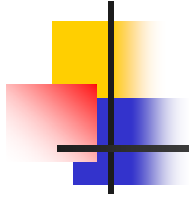


5 Conclusion



- Review some knowledge about patent and several typical ideation methods, and lead the insight into analogy-based design to achieve more patent applications for protecting the core technologies and extending the range of intellectual property.
- Focused on encoding the source and retrieving the analog, IPC analysis was applied into uncovering almost all the relevant function, behavior and structure information, and three abstract heuristics were put forward for candidate target systems retrieval.
- To illustrate the use of the studied method more clearly, a structured patentable idea generation frame was discussed, and the bladeless fan was selected as source design to generate more creative ideas.
- The representation of analogical information is effective and the idea generation process is beneficial for discovering innovative opportunities and patent application. But the heuristics to retrieve target candidates is just a general guideline and deserve to be explored further in the future research.





Thank you for your attention !

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