

BARBARA WASILEWSKA, RYSZARD KNOSALA*

STIMULATING TECHNICAL SOLUTIONS USING A HEURISTIC METHOD

STYMULOWANIE ROZWIĄZAŃ TECHNICZNYCH Z WYKORZYSTANIEM METOD O CHARAKTERZE HEURYSTYCZNYM

Abstract

The paper explains selected methods of stimulating innovative solutions as shown by the created model of creative problem solving. Heuristic methods allow for developing creative thinking for the development of an enterprise. Two case studies are presented using the methods typical for the studied enterprise.

Keywords: creative methods, innovations, production engineering

Streszczenie

Artykuł ma na celu przybliżenie wybranych metod stymulowania innowacyjnych rozwiązań na przykładzie utworzonego modelu kreatywnego rozwiązywania problemów. Metody o charakterze heurystycznym pozwalają kształcić zdolności myślenia twórczego w rozwoju przedsiębiorstwa. Zostaną przedstawione dwa studia przypadków z wykorzystaniem metod w badanym przedsiębiorstwie.

Słowa kluczowe: metody twórcze, innowacje, inżynieria produkcji

* M.Sc. Eng. Barbara Wasilewska, Prof. Ryszard Knosala, Institute of Processes and Products Innovation, Opole University of Technology.

1. Introduction

Creative thinking may be used in many different fields of human activity. Among the factors activating creativity are heuristic methods whose task is to facilitate action course in open situations problem [1, 2]. The appropriate stimulation for creating new ideas and solving tasks is indispensable nowadays. This type of mobilization allows one to independently create conditions for shaping a pro-innovative work environment. The action of solving problems usually starts the mode cycle of the creative process that allows for the obtaining of intellectual success. This usually involves three following phases: discovering the problem, creating new ideas and their verification and assessment. The creative process is usually long, however, it depends on the problem specifics and complexity. Therefore, it can be a discontinuous process that requires strong motivation and work discipline from the solver.

As shown by Kozielicki [3], heuristic methods provide a high probability of solving the problem. They facilitate the overcoming of obstacles such as functional fixedness defined as the attitude that limits a person to perceive an object only in one established, traditional way.

There are many ways to create valuable solutions, but it is necessary to perform a few steps to learn how to create them. The approach to innovation based on reason and current development [4] includes the following steps:

- choosing the best ideas based on their expedience and merchantability – this gives a rise to other important questions: how to manage ideas and which strategy should be adopted for creating reserves of such ideas? At this moment, the idea might be unrealisable, expensive or even superfluous, but the history of scientific research in many fields show that “the time brought practical application for even highly abstract problems and theories” [5, p. 69];
- determining existing company resources and evaluation of their usefulness in new tasks
 - Will the risky projects obtain support? Will the company require new personnel with creative potential? People need to learn creative thinking, just as they learn any other skills [6] and one of the ways to improve it within the organization is to involve employees in achieving set objectives in an elastic and open way in order to prevent the trend to reduce diversity and to stay on a beaten path [5];
- creating a new business model – employees, process, results.

While the approach to innovation based on imagination and trend anticipating [4] assumes the study of all possible solutions created as a result of a new perspective on company problems. It also suggests an expansion of the scope of the case study. This might involve looking for alternative problem solutions. Such an approach suggests rethinking the innovation context for a given company and the creative combination of the best ideas, using, for example, the variety of employees’ knowledge and their insights. Finally, it recommends the creation of new meaningful concepts that can involve people and improve their life quality at the same time.

Stimulating solutions requires a good understanding of the processes accompanying the formation of idea. This allows for the planning of correct procedures. The Nosal presents four types of cognitive situations [5], naming them type A, B, C, D. For the purposes of this paper, type C seems to be the most interesting – is an example of a situation that is innovative

activity. Type C includes: looking for a new environment; DIY principle; converting existing conditions; inexpedient routine. A creative person who plans to pursue an unusual goal in a typical environment can either change the environment or create a new idea on his/her own, step by step. Therefore, the innovative activity might be initiated from forming of creative problem solving skills, especially in stimulating technical solutions that are created in ordered and systematic manner.

2. Model of stimulating technical solutions by means of heuristic methods

The following methods were proposed for use in subsequent stages of problem solving in the creative processes indicated in the study [1]:

1. Perceiving new problems – Analogies.
2. Problem formulation and reformulation – Generative metaphor and Necessary and unnecessary.
3. Constructing the auxiliary problem – Content-rich realistic analogy, Visual realistic analogy and Personal identification.
4. Solving auxiliary problem – Self-solving problem and Unreality.

The tools for creative problem solving used in this article are a part of the model of stimulating technical solutions (Fig. 1). It was used for generating problems that were undertaken during creative sessions in the studied enterprise. This involves two stages of the creative process – defining the problem (defining the objective) and creating ideas. The presented general workflow can also be applied to existing rules and strategies of creative thinking. If they are unfamiliar to the reader, it is worth reading and understanding them before applying the method for creating ideas [see 7].

Analogies were used for problem detection. They are quite general and can be applied at different stages of the process, as well as for predicting and designing solutions. The other method was Fantasy Analogy that is reduced to wishful thinking. This allows creating a variety of ideas. The analogy mechanism was activated by the phrase: ‘What if...’ There were such questions as: if anything was possible, what would be your ideas?

The stage of problem formulation and reformulation should not be omitted as it enriches the process of looking for solutions by additional preparatory actions. One of the methods – generative metaphor is defined as “(...) object, situation or phenomenon forming a clear, though tacitly accepted, a reference to the problem in its current formulation” [1, p. 146]. The metaphor should determine a possible line for creating improvement ideas. The second method – ‘necessary and unnecessary’, is designed to determine the requirements for future solutions in order to maintain everything that is necessary and eliminate everything that is seen as unnecessary.

The stage of constructing insert the auxiliary problem also involved analogies. The rich-content realistic analogy assumes the ‘departure’ from the main task in a controlled manner. The task was compared to similar problems encountered in a completely different field of knowledge or ability. The visual realistic analogy refers to visual imagination and episodic knowledge gained through experience [4]. It can be expressed by words. The third method in this stage – the personal identification (in order to gain a deeper understanding of production

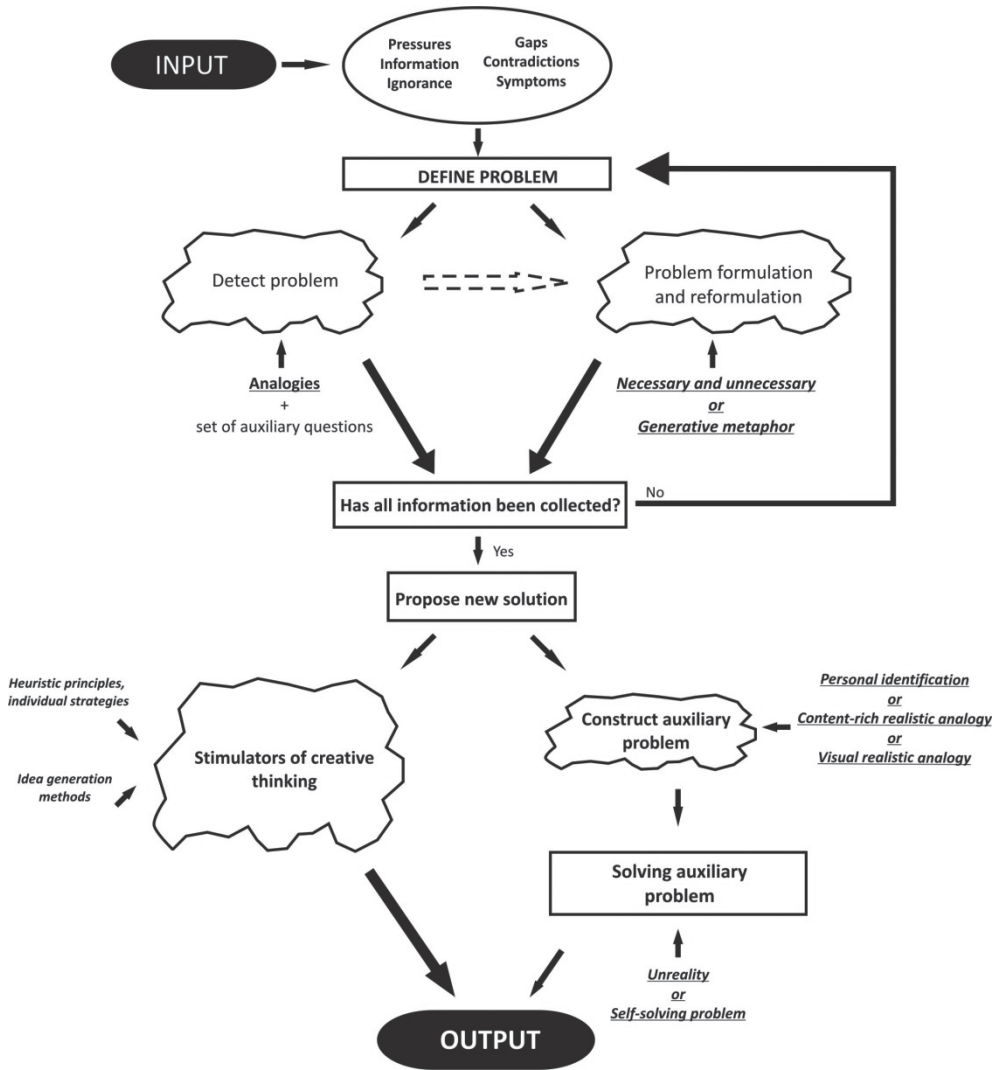


Fig. 1. Model of creative problem solving using heuristic methods

problem) suggests impersonating some machine components and analysing their weakest aspects. The problem that exists objectively is experienced by one’s own body [1].

The last stage involves the method of self-solving problem. It is an example of personification, i.e. attributing human characteristics to objects (physical objects, processes, whole tasks) [1]. Therefore, the question is asked: how can my problem find its own solution by itself? Thus, the problem itself is personified. While the method of unreality needs to get some ideas from fairy tales and fables. Their plot and characters may by themselves contain solutions.

3. Case study – improvement of the production system

Nowadays, the ability to perceive the need for changes and improvement, and the ability to initiate new approaches for multi-solution problems becomes more and more useful. The presented methods aim to be a source of inspiration for goals generally defined as improvement of the production system. The goal assessment is very broad and might involve either human element, existing procedures, selected field – position in the system etc.

3.1. Method of analogy for supporting problem perception

For keyword (improvement) can suggest any of the following analogies: golden mean; machine; system's Chinaman; perfect product; air after the storm; hair colouring, latest fashion trend; holy man. Such analogies allow for a more profound analysis of the task, because the improvement requires a new, refreshed perspective (e.g. air after the storm). It also needs a choice of recent solutions (e.g. latest fashion trend) that shall be quick and effective (e.g. machine) and, basically, they should be perfect – optimum for their dedicated function (e.g. holy man). However, this may force some artificiality, when based on assumption that improvement knows no end (e.g. hair colouring).

3.2. Generative metaphor supporting problem formulation and reformulation

Metaphors adequate to this subject are as follows:

1. Military – the proposition of the development of a strategic plan for production manoeuvres.
2. Education – the development of a production system syllabus.
3. Health – creating supplements that improve 'production health' and prevent relapses of production defects.

Did the metaphors facilitate finding a new idea or inspired solution? Certainly, they outlined surprising fields that can be a source for taking and developing new ideas based on personal expectations and research objective. People interested in a selected field (military, education, health) might find it desirable to develop the subject using other methods such as: *Purge* (for military) as the elimination of instant ideas from know issues; *Figure-background* (for education) in order to omit typical educational elements and consider neglected ones. Could it be unusual training methods? (for example collage technique, or forms embody the role of the production system?) The last example (for health) is *Problem as a subproblem*, because preventing a recurrence of production defects is a part of greater structure and formulate the problem should be wider, which will eliminate him.

3.3. Using realistic content-rich analogy and realistic visual analogy for constructing insert the auxiliary problem

The following examples seem to be valuable for constructing an auxiliary problem by means of content-rich analogies:

- how to properly season a dish?
- how to correctly finish a house?
- how to correctly repair a car?

Seasoning a dish is an improvement of an existing object, which however is not excellent at its core. Finishing a house requires many actions that occur in some order, this requires prior reflection. The repair points at elimination or reduction of the problem. The system requires appropriate ‘seasoning’, serving, a pinch of spice etc. The individual detail, department or part may be seasoned. I repair what is currently inappropriate, or was badly set in the past.

The other model of problem of the output may be too long downtime. The following examples come to mind:

- waiting for a green light,
- waiting in line in a shop,
- waiting for a helpline consultant.

What can be done to avoid waiting too long at a red light or accelerate the green light – avoid inhibition of subsequent stages of goods production? What other actions can be undertaken during waiting, just as when waiting in line? How to react to for delays of start of first production stage, in a similar way how we wait for quick and substantive connection?

The analogies regarding the elimination of time wasted during production were evoked for the issue of improvement of the production system. The following analogies can be distinguished:

- trains arriving late,
- tightening a tap to prevent water from dripping,
- waiting in a line to see a doctor.

For instance, the elimination of resulting delays may be impossible due to weather conditions, unexpected or new situations that could not have been foreseen in a perfect manner. Where in the system is it possible to tighten a dripping tap, which part is ineffective or does not show full effectiveness? As in the queue for the doctor reorganization of the system requires the work of people, willingness to change and introducing procedures of adequate behaviour in such situation.

3.4. Self-solving problem method for the auxiliary problem

If the production system behaves as a doctor then it diagnoses itself on its own – it can determine which part aches, it knows what to treat and it understands the need for regular prophylaxis to prevent relapse or further complications. If the problem could solve itself, it would be done through an operator panel which functions as an operator-machine interface and supports the user in the operating of the system by providing high precision. Through the integration of all devices working in one installation into one cohesive system, it is easier to find the causes of faults and downtimes. Table 1 presents data that could be placed in the panel with a drop-down list of causes, names of devices/line parts and part of automatic areas.

Table 1

Exemplary data for operator panel

1	2	3	4	5	6	7	8
Machine	Component	Cause	Stop	Start	Time	Team	Recipe No.

The improvement of the production system requires a new evaluation of the formed inspirations. Auxiliary stages were supposed to direct to solving the undertaken task. This way it is possible to get closer to the solution using a non-standard approach. The last of the methods used determines the final result a problem, it allows for a further elimination of problems in the way of the assumed solution.

4. Case study – increasing performance of production machines

In this part presents another example of issue in the studied enterprise – increasing machine performance in product manufacturing. It is an inspiration to stimulate creative thinking.

4.1. Method of fantasy analogy for supporting the perception of new problems

Problem detection allows for a better definition of the objective. The desired effect involves increasing the number of manufactured products, smooth operation without downtimes and decreasing failure rate. Table 2 presents five questions starting with the phrase ‘What if...’ which is aimed at developing the problem of a low number of products produced during one shift – the more questions, the better.

Table 2

Perceiving new problems using the Fantasy analogy

Fantasy analogy
Problem: low number of products produced during one shift
<p>1. <i>What if each employee would recorder production course at his work station?</i> Such actions would allow for faster diagnostics of machine failures.</p> <p>2. <i>What if machine of defined application produced the same number of products?</i> The amount of dosed material for extruder would have to be the same – the material would come from one supplier. No possibility of mixing or combining.</p> <p>3. <i>What if each machine had a temperature sensor?</i> The temperature sensor would allow for faster diagnostics of machine failures.</p> <p>4. <i>What if each machine had a system for signalling failure that directly informed the repair department?</i> The system would give data regarding which machine has failed and where it is located in the production hall.</p> <p>5. <i>What if each machine had a counter that displayed the number of manufactured components in a given time?</i> The counter would show the number of produced pieces and whether the worker made his quota during the shift. This would decrease the probability of employee error or fraud.</p>

4.2. ‘Necessary and unnecessary’ method supporting problem formulation and reformulation

The unnecessary was demonstrated to be installation of temperature sensors in production machines and installation of the computer at the station of injection moulding machine and recording process of the machine. The list of necessary actions was a bit longer. It includes the installation of cooling systems and counters in the machines as well as the replacement of old motors in selected production machines and increasing the size of tables (welder, press). As a consequence, the objective is still the same – to increase machine performance, which would result in an increase in the number of manufactured products. The planned number for one working shift shall amount to 120 pieces.

4.3. Using personal identification for the construction of the auxiliary problem

The chosen example created during a creative session based on this method will be presented. The effectiveness of this method increases with the frequency of its use. It is useful to impersonate a few different components to grasp the differences of the identification.

I am the extruder responsible for tape extrusion

I would install a temperature sensor that would measure my temperature so I could inform my employer in the case of overheating. I would also install the counter that would show how many components I produced and how long it took. Such a solution would allow me to verify which material is more effective. I would certainly replace the motor responsible for tape pitch. I hope this decreases my failure rate. Finally, I would install a cooling system to cool specific machine subsystems and avoid downtimes.

4.3. Unreality problem method for solving the auxiliary problem

The installation of a cooling system in production system evokes the story of the Wavel Dragon and King Krakus. The Wavel Dragon can be compared to high temperature in the machine, while King Krakus is the coolant that fights it. King Krakus, by fighting the dragon, makes the environment safe and restores peace and order, just as in the enterprise that uses a cooling system.

“When he ascended, Poland was wooden, when he left us, it was from stone” suggests the replacement of motors with obsolete designs that can be compared to wooden buildings from that period. The new motors, equipped with state-of-the-art technology, can be compared to stone buildings. This means higher durability and allows long-term operation, just as stone buildings can stand for many years.

5. Conclusions

Heuristic methods can create conditions for the emergence of new ideas. Sometimes the process of thinking grows and expands. The stimulation should not be an imposed scheme which is used in a strict manner. Rather, the scheme shall be built based on the nature of the

problem, but usually multi-solution problems require constant stimulation. As a result of the carried out creative sessions, unrealistic solution ideas can often emerge. The choice of more analytical and common sense methods or methods based on intuition and imagination depends on one's personal abilities. Combining them in harmony is the way to go.

References

- [1] Nęcka E., *TROP... Twórcze Rozwiązywanie Problemów*, Oficyna Wydawnicza „Impuls”, Kraków 1994.
- [2] Płóciennik E. et. all., *Metoda i wyobrażenia. Podręcznik dla nauczyciela. Lekcje twórczości w klasie I*, Wydawnictwo Difin, Warszawa 2009.
- [3] Koziński J., *Myślenie i rozwiązywanie problemów*, [in:] T. Tomaszewski, *Psychologia ogólna*, Wydawnictwo Naukowe PWN, Warszawa 1995.
- [4] Fisk P., *Geniusz biznesu. Kreatywne podejście do rozwoju firmy*, Wolters Kluwer Polska, Warsaw 2009.
- [5] Nosal Cz., *Umysł menedżera: Problemy – decyzje – strategie*, Wydawnictwo „Przecinek”, Wrocław 1993.
- [6] Henry J., *Creative Management*, Sage, Great Britain 2001.
- [7] Karlińska B., Knosala R., *Sesja twórcza jako sposób kreatywnego rozwiązywania problemów w przedsiębiorstwie*, „Zarządzanie przedsiębiorstwem”, 2/2013, 16-22.