

# THE EUREKA EFFECT: THE ART AND LOGIC OF BREAKTHROUGH THINKING

By David Perkins  
Norton Press, 2000

---

- Fivefold structure of breakthrough thinking
  1. Long search: Breakthrough thinking characteristically requires along search
  2. Little apparent progress: A typical breakthrough arrives after little or no apparent progress.
  3. Precipitating event: The typical breakthrough begins with a precipitating event. Sometimes external circumstances cue this moment. Sometimes a mental event is sufficient (e.g. finding right point of view.)
  4. Cognitive snap: The breakthrough comes rapidly, a kind of falling into place, a cognitive snap.
  5. Transformation: The breakthrough transforms one's mental or physical world in a generative way.
- The repertoire of moves behind breakthrough thinking includes not only analogy but also logical extrapolation, asking the right question, systematic large-scale search and repurposing.
- Margaret Boden, 1991, *The Creative Mind*: A merely novel idea is one which can be described and or produced by the same set of generative rules as are other, familiar ideas. A genuinely original, or creative, idea is one which cannot.
- For non-insight problems, how likely a problem solver is to solve a problem depends on how long the problem solver persists. Work longer, and you stand a better chance of reaching a solution. However, insight problems tend to be solved soon if at all. In an experiment, only 2% of correct solutions were given after 2 minutes.
- In breakthrough thinking, unexpected external circumstances often provide the precipitating event that triggers a cognitive snap. (e.g. Gutenberg goes to wine festival and connects grape press with printing press.)
- Klondike thinking
- Wilderness of possibilities: In breakthrough problems there are many tempting directions but few actual solutions.
- Clueless plateau: There are no apparent clues to point in the direction of a solution.
- Narrow canyon of exploration (canyon trap): Breakthrough problems trap the problem solver with a taken-for-granted assumption or a limited representation of the problem or fixation on a habitual pattern of thinking. The problem solver searches vigorously for a solution, but within boundaries that do not contain a solution.
- Oasis of false promise: Breakthrough problems tempt the problem solver with answers that are almost good enough, but not quite. It is hard to move away from them.
- Four operations of breakthrough thinking
  1. Roving: Exploring the possibilities widely, trying this and that
  2. Detecting: Looking harder for clues that point a direction
  3. Reframing: Consider constraints that you are taking for granted
  4. Decentering: Move away from seductive approaches that do not work
- Good breakthrough thinking systematically jumps the tracks of sequential reasoning.

- In breakthrough puzzles, it is often the absence of something that is a clue – what is not said that might have been said.
- Symptom: Large number of possibilities with few that are likely to pay off. Response: Rove far and wide without lingering
- Symptom: No apparent clues pointing in a promising direction. Response: Detecting
- Symptom: Confined. Response: Reframe
- Symptom: Beguiled into persistence. Response: Decentering.
- Functional fixedness: The tendency to see objects in their normal functions but not in less usual functions.
- Getting out of the canyon is a matter of identifying the boundaries that limit the scope of search and then reframing them.
- Search through space of possibilities
- The state (possibility) space: set of possible states of affairs (e.g. in chess, configurations of pieces on board)
- Operators: Actions that shift from one state to another (in chess, the legal moves)
- Initial states: In chess, the standard starting position
- Solution states: criterion determining solution (in chess, the criterion is checkmate)
- Measure of promise: how close the state-so-far is to a solution state or whether the search is moving toward or away from a solution state.
- In general, what may seem like a change in the possibility space can be thought of instead as a jump from one place to another within the possibility space caused by some factor not under one's control. Where one ends up has always been a possibility in the possibility space – it is just become actual. Rather than threatening the idea of possibility spaces, such jumps recommend exploring the possibility space more deeply, anticipating what unexpected events might happen.
- When people address formal problems, criteria for a solution are well defined from the beginning and stay constant. In open-ended problems, criteria often evolve during the course of problem solving.
- Cognitive scientists speak of heuristic search, the term heuristic referring to strategies that increase the chances of success without guaranteeing success.
- Heuristic (Greek: "Εὕρισκω", "find" or "discover") refers to experience-based techniques for problem solving, learning, and discovery. Heuristic methods are used to speed up the process of finding a satisfactory solution, where an exhaustive search is impractical. Examples of this method include using a "rule of thumb", an educated guess, an intuitive judgment, or common sense. The most fundamental heuristic is trial and error, which can be used in everything from matching bolts to bicycles to finding the values of variables in algebra problems. Here are a few other commonly used heuristics, from George Pólya's 1945 book, *How to Solve It*:
  - If you are having difficulty understanding a problem, try drawing a picture.
  - If you can't find a solution, try assuming that you have a solution and seeing what you can derive from that ("working backward").
  - If the problem is abstract, try examining a concrete example.
  - Try solving a more general problem first (the "inventor's paradox": the more ambitious plan may have more chances of success).

- Smart search in such a possibility space is a matter of thinking in ways that cope with the wilderness, plateau, canyon and oasis traps. It is a matter of setting sequential reasoning aside and being unreasonable in a smart way, on the lines of the four operations introduced earlier: roving around flexibly, detecting hidden clues reframing the situation and decentering from false promise.
- Inventors face the wilderness of possibilities in various ways, which could be organized into the following spectrum of search styles:
  1. Sheer chance: An invention not particularly sought gets discovered by an active searcher exploring widely and incidentally
  2. Cultivated chance: The searcher deliberately opens himself or herself to a variety of semi-random input, harvesting the occasional useful connections. This is one kind of roving.
  3. Systematized chance: The searcher systematically surveys a sizable number of options that fall within a defined set, seeking ones with the target characteristics. This is more systematic roving.
  4. Fair bet: The searcher conceives and develops one or a few prototypes, relying on science and craft, with reasonable expectations that one or another will serve.
  5. Good bet: The searcher conceives and develops a prototype from principle and experience that probably will work.
  6. Safe bet: The searcher deduces with formal methods something that almost certainly will do the job.
- All of these styles of search can be found in the inventors' accounts; however, the trend lay toward the middle – categories 3, 4, and 5.
- Brainstorming is the mind's dune buggy.
  - Rules for brainstorming
  - No criticism
  - Keep moving
  - Piggyback
  - Diversify
  - Begin with individual brainstorming, then move to group in order to avoid “group think”
- Chance is an engine of insight.
- Ohlsson identifies three different conditions that cue the problem solver to stand back and consider reframing a problem
- Restructure when stuck
- Restructure upon novelty: When interesting and surprising aspects of the problem emerge, this is a natural time to seek a new representation that accommodates them.
- Restructure upon overload: When it is difficult to keep track of all the information and trails at hand, a new representation that simplifies and organizes the situation may help.
- The trouble is, when you already know one specific answer, or even just the kind of answer you are supposed to have, that tends to shut out others. This is the oasis trap. The answer to it is decentering. Problems are often more open-ended than they look. The possibilities are endless, and the challenge is to find the good needles in the haystack of mediocrity.
- Considerable evidence shows that problem finding makes up a significant part of creativity.
- Three distinct processes are mechanisms of insight
  - Selective encoding happens when a thinker sorts through the given information and focuses only on the information relevant to solving the problem.

- Selective comparison occurs when the thinker discovers a nonobvious relationship between new information just put on the table and old information already in memory. Here the thinker may employ analogies, metaphors, and models to solve problems.
- Selective combination occurs when the thinker discovers nonobvious pieces of information and combines them to form novel and relevant wholes.
- The ability to apply the insight processes is fairly highly correlated with IQ.
- People with high IQs are slower, not faster, than people with lower IQs in analyzing the problems and achieving the insights. This shows that insightful problem solving is not always faster problem solving.
- People with higher IQs are more likely to have sudden realizations about an insight problem's solution.
- Insight can be trained on the basis of the three processes, and the training effects are transferable and durable.
- If incubation does occur, how might it operate?
- Energy recovery: After a break, the problem solver returns with more mental energy.
- Musing: While seemingly away from the problem, the problem solver occasionally and idly pokes at the problem.
- Fertile forgetting: Time away from the problem lets the problem solver forget about assumptions and approaches that are canyon and oasis traps.
- Pattern priming: Intense concentration on the problem has sensitized the problem solver to any sort of pattern that might constitute a clue. Doing other things brings the problem solver into contact with clues that never would have been encountered during focused work on the problem.
- Unconscious mental marathons: The problem solver's unconscious mind does serious extended thinking on a problem with consciousness directed elsewhere. In contrast with musing which involves brief conscious episodes while doing something else, this explanation proposes extended unconscious episodes of focused problem solving while doing something else.
- Problems look different when one knows a lot about them. Having the right knowledge and having it handy is part of what prepares one for insight.
- Knowing is not enough. Problem solvers often know enough but fail to access what they know. Many insight puzzles are crafted to encourage such failures of retrieval.
- Zeigarnik effect: Common experience that an unsolved problem seems to linger on the fringes of one's consciousness. Zeigarnik performed an experiment showing that people's memory for unsolved problems is superior to their memory for solved problems. Problems not just pursued but pursued to an impasse might be more likely to leave mental traces that would be activated by clues encountered later.
- Knowing the genre of a problem and taking advantage of it is a powerful way of thinking.
- Three psychological aspects of breakthrough thinking loom large: active knowledge, pattern priming, and breaking mental sets. As to the first breakthroughs inevitably depend on knowledge, but not just knowledge buried in the mind's basement. Breakthrough thinking requires not just possession of, but ready access to, the right knowledge. Pattern priming names the mental readiness that develops when struggling with a problem has us in it. Somehow, the effort and investment set up mental watchdogs that are likely to bark when a relevant clues comes along. Finally, having a mental set amounts to pattern priming in a negative direction. Breakthrough thinking involves breaking through such mental sets.

- Active knowledge, pattern priming, and breaking mental sets are part of what might be called not Klondike logic, but Klondike psychology. Klondike psychology has to do with what's difficult about breakthrough thinking for the human mind, and how the human mind sometimes dodges those difficulties.