THE COMPLETE METHOD OF CREATIVE PROBLEM SOLVING

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The following pages give a description and guide to the stages of the complete method of problem solving for all fields. Remember that this method is basically the same as the scientific method, which was recognized and developed by scientists with the help of philosophers, psychologists, and many others.

The problem-solving process is not just a collection of miscellaneous methods. People well educated in the problem-solving process do not proceed in a haphazard fashion. Centuries of trial and error, research, discussions, and debates have led to a realization of the general pattern of the problem-solving process. The pattern represents the major stages of how we originate, refine, extend, and apply knowledge in all fields. Thus, it is also the method of problem origination, prevention, solution, and challenge of solution.

There Are 11 Major Stages to the Problem-Solving Process

Each stage represents a different type of mental activity (usually aided by physical actions). The method is subject neutral.

While the stages are listed in the usual order of use, in actual practice they will be used in a flexible manner, since progress on complex problems is seldom smooth. There will be backtracking, skipping, false starts, looping, sub-problems, and other diversions.

The Supporting Ingredients of the Problem-Solving Process

The supporting ingredients in the SM-14 formula are ingredients rather than stages to help people understand “the method” and as an aid to teaching it. The stages do not constitute a complete picture of the overall system. The word “method” in “the complete method of creative problem solving” is a collective term for the stages. Problem solvers’ methods, techniques, procedures, and activities are ingredients 12-14. It is these ingredients that are used to actually accomplish results.

The SM-14 Formula for the Complete Method of Creative Problem Solving

Stages

1. Curious observation
2. Is there a problem?
3. Goals and planning
4. Search, explore, gather evidence
5. Generate creative and logical alternatives
6. Evaluate the evidence
7. Make the educated guess (hypothesis)
8. Challenge the hypothesis
9. Reach a conclusion
10. Suspend judgment
11. Take action

Supporting Ingredients

12. Creative, non-logical, logical, and technical methods
13. Procedural principles and theories
14. Attributes and thinking skills
Importance of Curiosity

Curiosity, when carried through all the stages of the complete method of problem solving, results in more jobs, increased wages, cheaper and more available foods, longer life and better health, improved housing, and a more pleasant and prosperous life for people in general. Albert Einstein stated:

“I have no special gift, I am only passionately curious.”

Einstein also said that the formulation of a problem is often more essential than its solution. A solution may be a result of mere skill while the discovery of a problem requires an inquisitive, curious mind, which stimulates further processes of:

- Inquiry
- Inference
- Discovery
- Experiment
- Identification of patterns/trends
- Logical reasoning
- Sense perception
- Deferral of judgment
- Predictive analysis
- Imaginative thought
- Theory development
- Sense perception
- Inference
- Logical reasoning
- Deferral of judgment
- Discovery
- Questioning
- Sensation
- Evaluation
- Reflection
- Skepticism
- Recognition of possible discoveries

Our Five Senses Are Used in Curious Observation

Observation is considered to be the most basic process of problem origination upon which all knowledge is built. We use our senses to activate our mental processes of interpreting and making inferences. All five senses — smelling, tasting, hearing, feeling, and seeing — are used in curious observation. Experiments, tools, and instruments such as computers, microscopes, telescopes, etc. must be used to extend our senses.

Develop These Personal Attributes

- Open-mindedness (try to eliminate biases)
- Progressiveness (be motivated to improve constantly and not be afraid of change)
- Be sensitive to the needs of people and society
Train Yourself to Be Curious

Ask “why?” Ask “how?” Ask “if?” Instructors of journalism courses such as investigative reporting teach the five W’s and the H: who, what, when, where, why, and how. In problem solving, “why,” “how,” and “what if” are the most important. Be sure to:

Ask “why?” Develop an inquisitive attitude, broaden your perspectives.
Ask “how?” How does it happen? How do we proceed?
Ask “what if…?” Speculate, imagine, visualize.
Don’t accept anything as a “fact.”
Learn subject matter in your field of interest.

Learn to be curious by always asking questions like “why,” “how,” and “what if?”

Curiosity Requires Better Thinking Skills

Think about thinking.
Develop your thinking skills. The term “critical thinking” really means problem solving. You should view difficulties as problems (or decisions) to be solved. Think reflectively (turn thoughts over and over in your mind; again, visualize and imagine). Individuals originate or find problems. Challenge authoritative statements, “truths,” and so-called “facts.”

Remember as You Proceed:

Stay curious at all stages! You should always have in your memory a supply of unsolved problems. Problem solving and decision making are processes that must move along the usual, flexible course of the stages presented here.

Next — Stage 2: Having found a problem, present it in the form of a question. If any solutions occur to you, consider them tentative no matter how good they may seem to you.
“Struggle is the essence of life — true happiness comes from being useful.”

Present in the Form of a Question

An idea, problem, decision, or tentative theory should be presented in the form of a question because:

It encourages you to keep an open mind, and thus seek the “truth” and not to prove a statement. A question is a tool and a guide for productive thinking about problem solving and investigation of a new subject.

Designing the Question:

- Be sure you ask the correct question.
- Get to the real problem; don’t be distracted by the symptoms.
- Consider your purpose, values, needs, goals, and criteria.
- Stick to the basics; don’t get lost in details.
- Too broad a question can never be solved, but too narrow a focus limits your results in this computer age.
- Be clear, purposeful, and thought provoking.

To Help Define the Problem:

- What are the critical elements, issues, and unique features?
- What is the initial state and goal state?
- What illustrative diagram can I prepare?
- What are some other views of the problem?
- What are the team members’ definitions of the problem?
- Problems frequently involve other problems — learn all that is involved.

Analyze for Subproblems

Most ill-structured problems are too complex to attack head on. Analyze and find the logical and important subproblems that are researchable by themselves. These subproblems must also be properly defined. Other subproblems will pop up as you proceed.
Are You Ready to Present Your Problem?

Do you have enough information to present a good question? If not, look ahead to Stage 4 and search, explore, and gather evidence first. For complex problems, keep a log.

Questions About Your Question:

- Is it probably solvable?
- Are you competent enough to solve it?
- Did you find the real purpose?
- Did you remember to avoid any biases?

Remember as You Proceed:

- Keep an open mind.
- Consider redefining the problem.
- Consider possible solutions as tentative ones.
- Be skeptical. Constantly challenge assumptions.
- Communicate with your associates.
- Remember that each complex problem is unique in its own way.

Next . . . Stage 3: Having thus formulated a problem, now consider your goals and planning strategies for solving the problem. In reaching your goals, you must first think about the end results you want to achieve and then think and plan ahead.
“Chaos is ended only by methods — Use SM-14.”

In today’s competitive environment, it is necessary to control time, labor, and budget, and to submit periodic reports and results. Therefore, in solving complex problems, we must have a stage for setting goals and carefully planning our work. These goals may change drastically as work progresses so they must be updated constantly. Goals should be described in writing, not just committed to memory.

Goals: Initial State — Present State — Goal State

- Must be realistic and feasible
- Should be both long and short term
- Cover the real purpose involved; stay properly focused
- Criteria and values must be involved
- Set target dates for stages and completion
- Aim for exactness on important points, but remember that perfection is not always affordable

Planning — Type of Problem

Problems are often classified in many ways. Three types are:

- Textbook, Exercise, Closed or Puzzle Problems: These are highly structured problems that students are taught to solve at all grade levels.
- Structured Problems: How to solve these problems is usually known or easily found out.
- Complex, Ill-Structured, Real-World, Open-Ended Problems: The way to solve these difficult problems is unknown and the means varies with each problem. Complex problems are covered in this booklet.

Planning: Do the Following:

- Keep a good list of tentative solutions.
- Place priorities on the subproblems.
- Organize your team and advisors.
- Utilize sketches and diagrams.
- Line up people, facilities, and supplies.
- Prevent troubles … anticipate difficulties.
Planning: Consider the Following:

- Data needed, what must be done
- Time, budget, contract requirements
- Laws, licenses, legalities, patent searches
- Environment and impact on society
- What action methods will you use?
- Consult people involved
- Read articles on planning

Remember as You Proceed:

Use a computer to help you. Computers were invented to provide problem solvers with figures, information, and procedural methods.

Use math and math programs whenever possible in problem solving.

There are many computer-based, mind-expanding programs and many more are constantly being developed. Utilize them.

Use the Internet as a source of information.

Find out if others have tried to solve this problem already.

Next . . . Stages 4 and 5: While Stages 4 and 5 are listed as separate stages, you should be aware the entire time that you are gathering evidence to be alert for creative and logical solutions.
You should start to search everywhere, explore all angles, leads, clues, and sources of information. Pick out the basic principles of the material you read, see, or hear. This is the heart of problem solving. Always try to use innovation and creativity, thus building your list of possible tentative solutions. Learn how to process information productively. Put your thoughts in writing.

Limited Information Principle:
Before loading your mind with data, other people’s opinions, and so-called “facts,” list all possible tentative solutions that you think of for your main problem and any subproblems because this:

- Provides you with direction and scope in your search
- Enables you to utilize imagination before being influenced by prevailing thoughts and theories
- Illustrates the need for always having an open mind

Use All Sources of Information:
- Utilize Internet search engines
- Prepare library program: read periodicals
- Visit new and used book stores and read catalogs
- Seek discussions with colleagues, friends, teachers, and members of organizations
- Take field trips: go to conventions
- Use checklists

Organize Your Data and Supplies
- Accumulate your own library
- Build a structured, well-organized paper file system
- Use Post-It notes to mark relevant pages
- Determine computer programs and files
- Decide what supplies and other materials you will need
Research Is Theory Driven:

In your search, you cannot wander all over the universe of data. A frequent comment in research literature is that problem solving is “theory driven.”

- Analyze your tentative hypotheses for a guide to areas to search
- Analyze your subproblems for directions to investigate

Maintain a Skeptical, Inquiring Mind:

- Anticipate the unexpected
- Draw inferences
- Challenge assumptions and interpretations
- Be flexible and vary your attack if necessary
- Always be curious

Remember as You Proceed:

- Narrow your field of search
- Data used must be “true”: screen thoroughly
- Develop a high capacity for self-instruction
- Be a team player at all times
- Carefully review conflicting opinions
- Evaluate and test your tentative hypotheses

Next…is also now! Read and study Stage 5 while you are searching and exploring so that you can also watch for and generate creative ideas (Stage 5). During Stage 5, you should make a special effort to add to your list of tentative solutions.
Generate Creative and Logical Alternative Solutions

“Science is an imperfect but phenomenally successful process.”

You must always be on the alert for alternative solutions. Generating creative and logical solutions is listed as a separate stage for emphasis of its importance and to be sure that you take a final look for ideas before starting to evaluate your tentative hypotheses. In actual practice, you should be watching for and originating ideas while working at Stage 4 in gathering evidence.

Logical Solutions and Trial and Error:

- Many problems can be solved by using gradual, systematic, steady, analytical, judicial reasoning, and logic
- Gather all the data and fit it together
- Trial and error is a standard method in problem solving

Innovative Solutions: Using Existing Ideas:

- Search for other people’s ideas
- Millions of ideas are buried in the literature
- Adapt, change, combine ideas for your particular problem
- Curiosity leads to discovery of ideas

Creative Solutions: Use of Imagination:

- Creativity is usually described as taking two existing ideas and combining them into a new and better idea.
- Creativity is also termed divergent or lateral thinking, insight, intuition, flash of inspiration, innovation, ideation, guided design, generative and/or productive thinking, etc.
- Visualize about your problem.
- Use reflective thinking and “triggers.”

Reflective or Speculative Thinking:

- Talk to yourself in both language and images.
- Daydream about your problem, even while doing other things.
- Jump back and forth between logical and creative, imaginative and wild, thinking.
“Triggers” Help Your Memory: Your mind has millions of bits of information stored in it that can be recalled by “triggers” or “joggers.”

- Read, skip, and skim a variety of periodicals, books, and Internet sites
- Experiment or visualize
- Attend conferences and exhibits
- Use check lists for problem solving

Use “Rest-Illumination”: Load your mind with data and information about your problem and then ...

- Rest, take a break, or sleep.
- Think about your problem again.
- Watch for illumination, ideas, and solutions.

Remember as You Proceed:

- Ask yourself, “Have I tried to originate alternative solutions?”
- Keep an open mind and stay alert for ideas and solutions throughout the remaining stages and even after the problem is “solved.”
- Anything (ethical) goes in problem solving.
- Be a risk taker since new ideas require idea champions.

Next . . . Stage 6: Now you have to chart your tentative solutions, test and evaluate the evidence and ideas you have accumulated thus far.
By now, you should have a list of tentative solutions that are candidates for your educated guess or hypothesis. This choice, usually called the “working hypothesis,” will be presented in Stage 7. It would be helpful to read the information at Stage 7 to familiarize yourself with the characteristics and traits your working hypothesis must have. You should also read Stage 8 to alert yourself as to how the hypothesis will have to be challenged extensively.

A Look Back Checklist:

- Problem: Should it be refined or reframed?
- Goal-reference approach: Evaluate where you started, where you are now, and where you still need to go.
- Planning: Are there any changes? Any further planning needed ahead?
- Are you being observant and creative?
- Log: Is it up to date? Are you using the right attributes, methods, technologies?
- Are you using team advisors and/or consultants? Are you alert to clues and leads?
- Are you keeping a balance between costs or risks and benefits?

Screen and Evaluate Your Tentative Hypotheses

- If data on any tentative hypothesis are insufficient, seek more information.
- Do they meet reasonable standards of acceptability?
- Should some be dropped before testing?

Evaluate mentally:

- Apply logical reasoning.
- Are your data bases reliable?
- Challenge any assumptions.
- Visualize statistical or mathematical analysis.
- Make predictions for testing.
Test and Experiment:

- Experiment controlling all variables.
- Use modeling, sampling, and graphs.
- Apply various computer programs.
- Design special instruments for testing.
- Test your predictions.

Chart Your Solutions to Weigh the Evidence: Criteria can be graded by as many facets, characteristics, or angles as you desire. You can have individual charts or a combined one. Tailor your headings to fit your problem.

Example—Possible Comparison Chart—Example

<table>
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<tr>
<th>Tentative Possible Solutions</th>
<th>Test Results</th>
<th>Suitability</th>
<th>Feasibility</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution A</td>
<td>Against</td>
<td>30%</td>
<td>Okay</td>
<td>50%</td>
</tr>
<tr>
<td>Solution B</td>
<td>For</td>
<td>50%</td>
<td>No</td>
<td>90%</td>
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</table>

<table>
<thead>
<tr>
<th>Tentative Possible Solutions</th>
<th>Test Results</th>
<th>Suitability</th>
<th>Feasibility</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution A</td>
<td>For</td>
<td>60%</td>
<td>Okay</td>
<td>90%</td>
</tr>
<tr>
<td>Solution B</td>
<td>Against</td>
<td>80%</td>
<td>No</td>
<td>20%</td>
</tr>
</tbody>
</table>

Remember as You Proceed:

- Attempt to falsify your theories as well as confirm
- Play the “devil’s advocate”— criticize your own ideas
- Tests must be repeatable by others who check your work

Next . . . Stage 7: You are now going to present your most likely solution as a working hypothesis that meets various qualifications. Based on it, you will make predictions for testing in Stage 8.
Your educated guess or hypothesis is sometimes called an informed guess, a tentative theory or decision, but “working hypothesis” describes it more exactly. It is a proposed solution to the most recent definition of your problem. It is your choice of the most-likely-to-be-successful solution from the list of contending ones that you have evaluated. At this stage, you must:

- Describe your working hypothesis clearly and simply.
- Be sure it has proper traits and characteristics of a hypothesis.
- Predict consequences of your hypothesis to be challenged in Stage 8.

Desirable Characteristics or Traits of a Hypothesis:

- Consistent with existing knowledge or data, but new evidence can dislodge a prevailing theory
- Verifiable or falsifiable by testing
- Relevant, fruitful, adequate, and logically possible

Working Hypothesis Used in All Fields:

- As the basis for a request for a research grant
- In natural sciences, should be a tentative theory about nature, or
- In social sciences, should be a tentative theory about one of life’s many problems, or
- In other fields, should be a tentative decision, plan, diagnosis of illness, idea, design, invention, etc.

The Method of Multiple Working Hypotheses: Decision making, social sciences, geology, and multiple causes may require the formulation of multiple hypotheses. Consider:

- The inexact sciences may require more than one concluding hypothesis
- Effort and attention are divided among more than one
- Your solution may involve all or be interlocking

Predicting Consequences:

In preparing for the challenge in the next stage, you must make predictions of why and how something will occur or the consequences based on the accuracy of your hypothesis such as:

- “This event will occur . . .”
- “A decision to . . . will result in . . .”
- “This experiment will show . . .”
- “This survey or interview will reveal . . .”
- “If this hypothesis is correct, the consequences will be . . .”
Computers Are a Great Help in Predicting:

- If a model is programmed, it will show . . .
- An artificial intelligence program will prove . . .
- A cost v. benefits program will show . . .
- A mathematical program will determine . . .

Remember as You Proceed:

- At each stage, remember to review the “Look Back” checklist at Stage 6, page 18
- Before making predictions, review what generated the hypothesis that is “on trial”
- A hypothesis is also called an “educated guess” because it has long been recognized that it is difficult to arrive at real “truth”
- Learn to abstract concepts from material you read

Next . . . Stage 8: One of the reasons that the Complete Method of Creative Problem Solving is self-correcting is that it requires you at the next stage to rigorously challenge your own working hypothesis.
At this testing and experimenting stage, you must do a far more complete and intensive challenge of your working hypothesis than you did at Stage 6. This special effort is one of the features that make this method self-correcting. Use the special skills and qualities possessed by any of your team members to help you effectively challenge your working hypothesis. Beware of your own and others’ possible self-deception.

Methods of Challenging Your Working Hypothesis

- Verification, justification, and validation
- Falsifying or disconfirming
- Testing your own predictions
- Put into actual use on full or test basis
- Present a contrary or competing hypothesis and try to support it

Verification, Justification, and Validation

This and the falsification theory are complicated subjects on which there is a whole body of literature. Here are five basic ways to verify, justify, and validate (you should use all possible ways).

- Observation, test, and/or experimentation
- Mathematical calculations
- Statistical verification, sampling, surveys
- Verification by elimination of all competing hypotheses
- Verification by consistency with existing knowledge

Falsifying or Disconfirming

It is a human tendency to support one’s own beliefs, but accurate problem solving requires that you make an effort to seek and to consider impartially all disconfirming evidence.

- Others are sure to try to falsify your hypothesis
- Construct a fault tree of possible failures
- Pay special attention to tests or predictions that are negative
Testing Your Predictions

- Predict what will and will not happen
- Be exact – reexamine results
- Have others check your procedures
- Utilize instruments, surveys, etc.
- Use ingenuity and imagination in devising tests
- Determine which are false, probably true, or supporting

Modify Your Hypothesis Often

- As you proceed, rate your confidence in your hypothesis
- Hypotheses are repaired more often than they are falsified
- Even an erroneous hypothesis can be of value by pointing us in the right direction

Should any of your old tentative solutions be combined with your working hypothesis now?

If necessary, backtrack to a previous stage

Remember as You Proceed:

- Control variables in your tests. Keep all other things constant to isolate the effects of one variable.
- Your tests and experiments must be repeatable by you and others. Be sure to log them.
- Chart factors for, against, and what could go wrong.
- Be skeptical but always keep an open mind.
- Be impartial . . . Don’t fall in love with your hypothesis.

Next . . . Stage 9: After you have finished your severe and sincere challenge, you must present your conclusion and explanation and take a final “look back.”
The time has come to reach a conclusion or decision.

You have submitted your working hypothesis (Stage 8) to a “real trial by fire.” You have gathered a large amount of new data and evidence. Based on this, you can:

- Reject your working hypothesis and go in a new direction.
- Modify your hypothesis, then backtrack or look back at a previous stage and start again.
- You can approve your working hypothesis as your new theory, idea, decision, system, and conclusion and now review your final conclusion.

Qualities Your Conclusion Should Have

- An answer to the problem, as you have finally defined it
- Broad enough to fit all acceptable data
- Limited enough to meet special exceptions
- Consistent when tested by you (and others) again and again
- Provides for possible future needs
- Fits into present system
- Is practical and implementable

Now, an especially good “look back” to reevaluate your investigation.

Have you . . .

- Gathered enough information?
- Performed experiments properly?
- Considered the environment?
- Controlled variables properly?
- Made any other possible goofs or errors?
- Considered all consequences?
- Ignored any contrary evidence?
- Made “facts” fit the theory?
- Considered ethics?
- Eliminated bias?
- Made any incorrect assumptions?
- Overlooked anything?
- Gotten feedback?
- Ruled out fraud by teammates?
- Considered all criteria?
- Done the math correctly?
Prepare for Your Work to Be Reviewed by Critics and Others

- Define unusual terms; mention assumptions and limitations
- Include bibliography of literature you reviewed
- Make speculations, predictions, and recommendations about your research
- State any limitations, ifs, ands, and buts

Significance of Your Conclusion

Your hard work has made you more familiar with your problem and conclusion than others, so be prepared at Stage 11 to

- Make suggestions or recommendations about what should be done
- Speculate about what should be investigated
- Report new problems or conclusions you create

Status of Your Conclusion or Theory

Even if you faithfully followed the requirements of SM-14, you still cannot claim your theory as truth or fact, but you can say

“Based on the evidence available today, the balance of probability favors the view that . . . (your conclusion).”

Remember as You Proceed

- In problem solving and decision making in the “inexact” social sciences, your conclusions may have to be an intelligent compromise.
- The solution of any problem (and its acceptance) depends on good human relations; consult those who will be affected by your conclusions.
- The old is destroyed with the presentation of your new theory – expect resistance.

Next . . . Stage 10: You are probably convinced that your solution is correct, but an important principle in the complete method of creative problem solving is to suspend judgment.
This is the stage for deep mental reflection. The nature of knowledge requires that you possess some humility about the results of your work, even though you are ready to take action. While you have spent a lot of time and effort to reach a final conclusion, you must now change your attitude and suspend judgment. Do not fall in love with your final hypothesis. Watch for other concepts or trains of thought now and in the future.

Dr. Crooks’ 1958 Advice on Suspended Judgment

• Stick to your conclusion until it is proven wrong.
• Keep an open mind and be ready to accept new evidence.
• Opinions thought correct today in light of present knowledge may be thought incorrect tomorrow because of new discoveries or projection of new ideas.

Condensed Definitions of Knowledge Types for Problem Solvers

Through the ages, people have struggled (and still do) to try to describe what “knowledge” is. But there is universal agreement on one point: Knowledge is forever changing and ever expanding. Therefore, suspend your judgment at all times.

Common Sense and Common Knowledge

There is a large body of common knowledge, and individuals tend to draw heavily upon it in their daily activities. Consider that:

• Some common knowledge is false, a half-truth, conflicting, inconsistent, superstitious, fragmented, and imprecise. However, time and practical application have produced a lot of reliable “common” knowledge.
• Your studies, reasoning, and experiences transform a lot of it into what you believe is reliable knowledge.

“Scientific” Knowledge in Organized Domains

Today there is reliable scientific knowledge ranging from the trivial to the fundamental being produced in many domains since many domains have practitioners who use the scientific method, peer review, and publication of research results.
Three Classes of “Scientific” Knowledge

- Class C (good) – “on the evidence available today, the balance of probability favors the view that . . . “
- Class B (better) – “On the peer-reviewed evidence available today, the balance of probability, plausibility, and consensus favors the view that . . . “
- Class A (best) – “Based on the peer-reviewed evidence available today which has been repeatedly tested and applied, the balance of probability, plausibility, and consensus favors the view that . . . “

Remember as You Proceed:

*From studying SM-14, you learn that anyone willing to research and follow the stages of SM-14 in accordance with supporting ingredients 12, 13, and 14 can produce or verify reliable knowledge. The degree of reliability depends on the quality of the methods, procedures, attributes, and thinking skills of the researcher, and the complexity of the subject matter.*

*Next . . . Stage 11: At last, the results of your efforts to produce reliable knowledge are put to use or made known to the world. WARNING: Winning acceptance is usually not easy.*
The action stage is also the “gaining acceptance” stage.

No matter how great your solution, decision, or theory may be, expect to meet great resistance to change. Have the courage, however, to go forward to present, sell, fight for, or whatever is required to gain acceptance for your work.

Members of the organized domains submit their work for peer review.

The system of producing reliable “scientific” knowledge requires that the knowledge a researcher produces using the complete method of creative problem solving (the scientific method) be submitted to peer review in published journals or domain meetings.

If you are not a member of an organized domain, post your work on the Internet and send press releases or articles to magazines in your field.

Other possible actions

- Publish a book, report, and /or pre-prints
- Submit a report to your superior and/or colleagues
- Apply for a patent or copyright
- Commercialize your idea
- Use your idea for personal purposes
- If you are in school, enter a contest
- Implement your idea or decision

Extend the productivity of your research

- Look ahead – mention possibilities in your report that others may not see.
- Did you see any instances in which actions or investigations might prevent problems in the future?
- What new problems does your report reveal?
- Make predictions based on your results. Offer clues and leads.
Obstacles to acceptance

Many eventually successful hypotheses have had a rough road to acceptance. Others have won immediate popularity. Thus, your action may have to include overcoming these obstacles that cause people to reject new things.

- Jealousy/bias
- Loss of prestige
- Financial loss
- Authoritarianism
- Poor reasoning
- No market
- Wrong assumptions
- Not enough proof
- Refusal to admit they’re wrong
- Organized skepticism

Aids to gaining acceptance

- Throughout Stages 1 through 10, be thinking of ways you might gain acceptance of your expected solution.
- Use your communication skills.
- If you run into a roadblock, make an end-run around it.
- Form a group to help you.
- Compile a list and write those who will benefit most from your results and report.

Remember as You Proceed:
As you wind up the final stage

- Look back — keep the problem solved. Progress requires continuous improvement.
- Give proper credit to your team, reference sources, etc.
- Report social and ecological effects of your results.
- There may be further problems to solve before practical use is made of a solution. Continue to use SM-14.

Next . . . SM-14 is not only a problem origination and solving method or guide, but it is also a complete system of refining, extending, and applying knowledge. The next three Supporting Ingredients contribute to understanding the system. The following pages about Ingredients 12, 13, and 14 will help guide you. Your success depends on their proper application.
The word method can mean many things. “Method,” as used in the title of SM-14, means the stages of problem solving. At Ingredient 12, the methods described are action types that are applied directly to problem solving at every stage of the complete method of creative problem solving.

“Methods” at Ingredient 12 include such elements and auxiliary actions as

- processes
- operations
- systems
- tactics
- programs
- strategies
- approaches
- procedures
- criteria
- techniques

It should be understood that there is not an exact line dividing types of methods, as one type often blends into another. The use of illumination can produce a creative method, a non-logical one (e.g., a wild guess), a logical one, or a technical one.

There are millions of problem-solving methods.

- There are only 11 major stages to problem solving.
- But there are millions of methods used at these stages.
- Thousands of new ones are developed each day.
- There are hundreds of frequently used methods.
- In fact, there are so many that all I can do here is describe the basic types.

Creative Methods

- Creativity often involves a combination of old ideas to produce a new idea or solution.
- A body of methods has developed for improving creativity.
- Four important creative methods are reflective thinking, rest illumination, triggers, and brainstorming.
Non-Logical Methods

While it may not be “scientific” to use non-logical methods, nevertheless, in actual practice scientists and all problem solvers are always using them. Time is often the main reason these are used. Some non-logical methods result from pure guess, habits, emotions, trial and error, arbitrariness, haste, frustration, closed-mindedness, experimenting, unreasoned opinions, risk taking, intuition, etc. Be alert to whether these methods affect your results favorably or unfavorably.

Logical Methods (in the broadest sense)

Any method based on sound reasoning is classified here as logical. Some researchers may apply logical methods based on accepted rules of reasoning standardized by logicians. Usually, however, people use “semi-intuitive” logic resulting from their base of experiences, thinking skills, and knowledge. Examples of well-known logical methods based on reasoning and experience are

- Controlled variation
- Surveying
- Falsification
- Reviewing the literature
- Pattern identification
- Trial and error
- Classification
- Artificial intelligence

Technical Methods

No standard exists to determine what methods to term “technical.” A method involving measuring, mathematics, use of tools, instruments, and apparatus can be termed “technical.” Some authors point out that these technical methods are really the only ones that can accurately be called methods of science or scientific methods, since most others are used in all fields.

Remember as You Proceed:

- “Method” in the title of SM-14 represents stages.
- A “method” here is the one that actually produces results when directly applied.
- Learn some of the more important and commonly used action methods, such as controlling variables.
- Originate your own methods that will help you as you go through Stages 1-11.
- Build your own intuitive base.

Next . . . Methods are effective problem solvers, but only if they are applied properly. Next, we consider factors in how they can be applied properly.
The complete method of creative problem solving was originally developed mainly by scientists and called numerous names, such as the scientific method, the method of discovery, the method of inquiry, etc. Even though it is not perfect, it was such a phenomenally successful method that this scientific approach spread to all domains. There are no official standards for the procedures used in the method, but a body of thought has emerged, some of which is presented here as a guide. Controversy exists about some, if not all, of them. Because they do not always apply to every circumstance, they must be considered and applied with an open mind.

The Organized Domains

These domains have their peer review systems, professional or trade organizations, customs, sharing of data traditions, rigorous policing, consensus of opinions, ethical standards (both written and unwritten). They also have constant debates over the structure of their domain, their “organized body of knowledge,” about research reports, theories, and methods. Even so, they have been very productive, so look to them for leadership in procedural principles and theories. They have been largely responsible for those which follow.

Proceed in a Systematic Manner

While the method can be used flexibly, you still must maintain control of the evidence, your procedures, and your reasoning. You must

- Gather All Evidence. If bias or inadequate effort causes you to ignore or fail to find available contrary evidence, you will not arrive at the “truth.”
- Take a Critical Attitude. A critical attitude toward authoritative statements and assumptions is required in seeking the “truth.” Data used in your thinking must be “true” insofar as it is possible to determine “truth.”
- Evaluate Your Values and Ethics. As much as humanly possible, a researcher should strive to be free of the prejudice and bias that often creep into human judgment and action. He or she must give due credit to his or her team and/or collaborators.
- Use Mathematics. Quantitative methods should be used whenever possible.
The Objectivity of the Complete Method of Creative Problem Solving

The basic purpose of the method is to originate, refine, extend, and apply knowledge while seeking the “truth,” although the “truth” can probably never be determined. Results must always be held open to extension, modification, even possible replacement. Usually, results should fit into our pre-existing body of organized knowledge.

- **Infallibility.** No claims should be made that the method produces infallible solutions. Rather, state “On the evidence available today, the balance of probability favors the view that . . .”
- **Experimentation.** Whether on a blackboard, computer, in a lab or the classroom, testing and experimentation are usually essential activities for the use of SM-14. Government standards must be observed in experiments involving people, animals, and the environment.
- **Replicability.** Care and exactitude must be high at all times. Results must be reproducible.
- **Falsification.** Endeavor to falsify as well as support your hypothesis.

Remember as You Proceed:

- There is a growing interest in the concept that problem solving is a social activity. It has long been felt that a researcher should be concerned with what is true and false, and not inject his or her personal values about what is good, bad, morally correct, or best for society. Be aware of this controversial situation.
- All individual stages of the SM-14 method have various procedural principles, theories, and thinking skills peculiar to them. See Stages 1 through 11.
- Never forget that the long-term basic objective of problem solving is to make this world a better place to live.
- In complex problem solving, “anything goes” as long as it is honest and ethical.

Next . . . Ingredient 14 concerns the quality of the human activity applied to the various stages in using the action methods and procedural principles and theories.
The Need for Attributes and Thinking Skills

Applying the action methods and procedural principles must be done by using proper personal attributes and thinking skills to achieve success. Doing this is one of the main reasons scientists over the centuries have originated and solved so many problems, thus achieving such phenomenal benefits for society. There is some overlap between personal attributes and thinking skills. They may also vary according to the domains and sub-domains in which a person works.

Personal Attributes

A definition of personal attributes also includes character traits, aptitudes, skills, values, attitudes, etc. There are a great number of desirable attributes mentioned in problem-solving literature. Those most frequently recommended include:

- Honesty
- Attitude
- Skeptical
- Seeks truth
- Courageous
- Curious
- Passionate
- Flexibility
- Creative
- Efficient
- Suspends judgment
- Open minded
- Knowledgeable
- Logical reasoner
- Emotional stability
- Sensitivity
- Team worker
- Motivated experimentation
- Communicator

Develop Your Team-Player Abilities

Problem solving and decision making are becoming more a matter of team work, as projects are large, complicated, and expensive, while usually requiring specialists as well. You should:

- Enroll in team training and team management classes.
- Recognize personality styles you must be able to blend with.
- Contribute to building team spirit.
- Carry your share or more of the load.
- Remember that your standards are not always those of others.
Communication skills

Educators and employers increasingly stress the importance of verbal and written communication skills.

- Develop your reading, writing, editing, and speaking skills.
- Team work depends on good communication skills.
- Hone your communication skills so that you will be able to excel in a team work environment.
- Submit reports in the format of SM-14’s stages.

Thinking Skills

In this limited amount of space, I can only impress upon you the need to analyze and develop your ability to learn and use the thinking skills necessary to adjust to the many changes in our fast-developing world. Two primary thinking skills are always used in problem origination, solving, and challenge of solution. They are the basic ways of thinking and are termed induction and deduction.

- **Induction.** This is another controversial subject. For you and me, however, the standard textbook definition is understandable. Professor Huxley gave this example many years ago. Suppose you bit into small, hard, green apples. Each one tasted sour. You then make a generalization that all small, hard, green apples are probably sour. This is inductive reasoning (or from the specific to the general). Stages 1 through 7 are generally considered the inductive stages of SM-14.

- **Deduction.** Suppose, then, that you picked up a small, hard, green apple. By deductive reasoning (from the general to the particular), you decide that it must be sour too. Stages 8 through 10 of SM-14 are generally called the deductive stages.

Remember:

*Although you have reached the last ingredient of SM-14, remember that you are not done. It has been predicted that by the year 2020, knowledge will double every 70 days. Because of the Internet, the availability of information and knowledge is changing, doubling, and becoming more complex at an explosive pace. But what doesn’t change are the basic stages of SM-14, the natural method that has existed and been unwittingly used by us in some form since the dawn of humans. So learn and practice using SM-14 . . . you can do it! Using it will make you happier, more successful, and a better judge of other people’s problem-solving abilities.*
**YOUR GUIDE AND WORKSHEET FOR APPLYING THE COMPLETE METHOD OF CREATIVE PROBLEM SOLVING AND DECISION MAKING (SM-14)**

<table>
<thead>
<tr>
<th>Stages or Ingredients of SM-14</th>
<th>Space for Your Comments and Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Curious Observation</strong></td>
<td>Method or guide keeps our thoughts en route to new reliable knowledge.</td>
</tr>
<tr>
<td><img src="image" alt="Cat Observation" /></td>
<td>Be alert — What is needed? — Be skeptical — Discover problems. Ask why?</td>
</tr>
</tbody>
</table>

**2. Is There a Problem?**

![Man Confused](image)  
Analyze problem carefully. Einstein said, “A problem properly defined is often half-solved.”

**3. Goals and Planning**

![Target](image)  
Break problem down into sub-problems. Consider any solution......

**4. Search, Explore, and Gather the Evidence**

![Detective](image)  
Search the Internet, books, and other sources. Follow leads. ..... Build files.

**5. Generate Creative & Logical Alternative Solutions**

![Puzzle](image)  
Search for ideas, read publications to trigger your imagination......

**6. Evaluation**

![Fingerprint](image)  
If possible, chart evaluations of your tentative solutions...... and test.
7. Make the Educated Guess (Hypothesis)

State your working hypothesis explicitly. Make predictions for testing.

8. Challenge the Hypothesis

Test. Experiment. Control variables. Attempt to falsify.

9. Reach a Conclusion

Can others test and confirm your conclusions?

10. Suspend Judgment

Keep an open mind and be ready to accept new evidence. Knowledge is forever changing.

11. Take Action

Submit your theory to peer review or take other appropriate action. 
### Additional Notes:

Follow those used by researchers everywhere, but “anything goes,” if ethical!

Be honest, a teamworker, communicate, etc. Use creativity — reason logically.

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