Pathways to Higher Education Project

Center for Advancement of Postgraduate Studies and Research in Engineering Sciences, Faculty of Engineering - Cairo University (CAPSCU)

Cairo University

Systems and Creative Thinking

Prof. Dr. Shaker Abdel Hamid Soliman

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by
Prof. Dr. Shaker Abdel Hamid Soliman
Professor of Psychology of Creativity
Academy of Arts, Egypt

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Tel: (+202) 5716620, (+202) 5678216
Fax: (+202) 5703620
Web-site: www.capscu.com
E-mail: capscu@tedata.net.eg

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Acknowledgment

On behalf of Pathways to Higher Education Management Team in Egypt, the Project Coordinator wishes to extend his thanks and appreciation to the Ford Foundation (FF) for its full support to reform higher education, postgraduate studies and research activities in Egypt. The Management Team extend their special thanks and appreciation to Dr. Bassma Kodmani, Senior Project Officer at the Ford Foundation office in Cairo, who helped initiate this endeavor, and who spared no effort to support the Egyptian overall reform activities, particularly research and quality assurance of the higher education system. Her efforts were culminated by the endorsement to fund our proposal to establish the Egyptian Pathways to Higher Education project by the Ford Foundation Headquarters in New York.

The role of our main partner, the Future Generation Foundation (FGF), during the initial phase of implementation of the Pathways to Higher Education Project is also acknowledged. The elaborate system of training they used in offering their Basic Business Skills Acquisition (BBSA) program was inspiring in developing the advanced training program under Pathways umbrella. This partnership with an NGO reflected a truly successful model of coordination between CAPSCU and FGF, and its continuity is mandatory in support of our young graduates interested in pursuing research activities and/or finding better job opportunities.

The contribution of our partner, The National Council for Women (NCW), is appreciated. It is worth mentioning that the percentage of females graduated from Pathways programs has exceeded 50%, which is in line with FF and NCW general objectives. The second phase of the project will witness a much more forceful contribution from the NCW, particularly when implementing the program on the governorates level as proposed by CAPSCU in a second phase of the program.

We also appreciate the efforts and collaborative attitude of all colleagues from Cairo University, particularly the Faculties of Commerce, Art, Mass Communication, Law, Economics and Political Sciences, and Engineering who contributed to the success of this project.

Finally, thanks and appreciation are also extended to every member of the Center for Advancement of Postgraduate Studies and Research in Engineering Sciences (CAPSCU), Steering Committee members, trainers, supervisors and lecturers who were carefully selected to oversee the successful implementation of this project, as well as to all those who are contributing towards the accomplishment of the project objectives.

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CU Cairo University **NCW National Council for Women**
FF Ford Foundation **FGF Future Generation Foundation**
CAPSCU Center for Advancement of Postgraduate Studies and Research in Engineering Sciences, Faculty of Engineering - Cairo University

Publisher Introduction

The Faculty of Engineering, Cairo University is a pioneer in the field of learning and continual education and training. The Center for Advancement of Postgraduate Studies and Research in Engineering Sciences, Faculty of Engineering - Cairo University (CAPSCU) is one of the pillars of the scientific research centers in the Faculty of Engineering. CAPSCU was established in 1974 in cooperation with UNIDO and UNESCO organizations of the United Nations. Since 1984, CAPSCU has been operating as a self-financed independent business unit within the overall goals of Cairo University strategy to render its services toward development of society and environment.

CAPSCU provides consultation services for public and private sectors and governmental organizations. The center offers consultation on contractual basis in all engineering disciplines. The expertise of the Faculty professors who represent the pool of consultants to CAPSCU, is supported by the laboratories, computational facilities, library and internet services to assist in conducting technical studies, research and development work, industrial research, continuous education, on-the-job training, feasibility studies, assessment of technical and financial projects, etc.

Pathways to Higher Education (PHE) Project is an international grant that was contracted between Cairo University and Ford Foundation (FF). During ten years, FF plans to invest 280 million dollars to develop human resources in a number of developing countries across the world. In Egypt, the project aims at enhancing university graduates' skills. PHE project is managed by CAPSCU according to the agreement signed in September 22nd, 2002 between Cairo University and Ford Foundation, grant No. 1020 - 1920.

The partners of the project are Future Generation Foundation (FGF), National Council for Women (NCW) and Faculties of Humanities and Social Sciences at Cairo University. A steering committee that includes representatives of these organizations has been formed. Its main tasks are to steer the project, develop project policies and supervise the implementation process.

Following the steps of CAPSCU to spread science and knowledge in order to participate in society development, this training material is published to enrich the Egyptian libraries. The material composes of 20 subjects especially prepared and developed for PHE programs.

Dr. Mohammad M. Megahed
CAPSCU Director
April 2005

Foreword by the Project Management

Pathways to Higher Education, Egypt (PHE) aims at training fresh university graduates in order to enhance their research skills to upgrade their chances in winning national and international postgraduate scholarships as well as obtaining better job.

Pathways steering committee defined the basic skills needed to bridge the gap between capabilities of fresh university graduates and requirements of society and scientific research. These skills are: mental, communication, personal and social, and managerial and team work, in addition to complementary knowledge. Consequently, specialized professors were assigned to prepare and deliver training material aiming at developing the previous skills through three main training programs:

1. Enhancement of Research Skills
2. Training of Trainers
3. Development of Leadership Skills

The activities and training programs offered by the project are numerous. These activities include:

1. Developing training courses to improve graduates' skills
2. Holding general lectures for PHE trainees and the stakeholders
3. Conducting graduation projects towards the training programs

Believing in the importance of spreading science and knowledge, Pathways management team would like to introduce this edition of the training material. The material is thoroughly developed to meet the needs of trainees. There have been previous versions for these course materials; each version was evaluated by trainees, trainers and Project team. The development process of both style and content of the material is continuing while more courses are being prepared.

To further enhance the achievement of the project goals, it is planned to dedicate complete copies of PHE scientific publications to all the libraries of the Egyptian universities and project partners in order to participate in institutional capacity building. Moreover, the training materials will be available online on the PHE website, www.Pathways-Egypt.com.

In the coming phases, the partners and project management team plan to widen project scope to cover graduates of all Egyptian universities. It is also planned that underprivileged distinguished senior undergraduates will be included in the targeted trainees in order to enable their speedy participation in development of society.

Finally, we would like to thank the authors and colleagues who exerted enormous efforts and continuous work to publish this book. Special credit goes to Prof. Fouad Khalaf for playing a major role in the development phases and initiation of this project. We greatly appreciate the efforts of all members of the steering committee of the project.

Dr. Sayed Kaseb — **Project Manager**

Dr. Mohsen Elmahdy Said — **Project Coordinator**

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Course Objectives

1. To **define** systems and creative thinking and other associated techniques.

2. To **introduce** practical concepts for application on the personal level and at the workplace.

3. To **determine and detect** how the creativity that exist in all of us can be systematically developed and harnessed to solve problems and improve performance at both the personal and the organizational level.

Chapter 1: Introduction

Introduction

A system is composed of interrelated parts

By definition, **a system is composed of interrelated parts.** In systems theory, the degree of interrelationship is termed the **"wholeness"** of the system. If the operation of every part of a system **is related to every other part**, wholeness is said to be **high**. And in fact, an outcome measure taken from any part of such a system will represent **the effectiveness of every part** of the system to the extent that other parts enter into the outcome. Because all parts are interrelated, all of the outcome measures taken from this system will be complex measures reflecting the operation of every other part of the system and will be substantially i**ntercorrelated**.

For logical purposes, it is useful to **contrast a system of high wholeness to a nonsystem** in which **no parts are interrelated.** *Measures of outcome would not reflect the operation of other parts measured and would not be Intercorrelated.* This is so obvious that it seems silly. But the converse, stated above, is not so easily grasped: outcome measures from different parts of a system are correlated because those **outcomes** are jointly **determined by common parts of the system**.

What we hope is obvious is that the parts of the system themselves are **interrelated** but are theoretically **independent in their unique operation.** The only way to demonstrate this independence is to obtain **less complex measures** of outcome of that particular part of the system which are free of the effects of other parts of the system. *As an example, the quality of the library staff would be one variable contributing to library size, A test of librarianship skills could be devised and administered to the library staff It would certainly be expected that the results of this test would be less correlated with university quality than would be library size*. That is, the more molecular the measure, the less intimately it would be expected to he related to global indices of system functioning. However, more molecular measures would give more specific information about system functioning,

We believe the same holds true for **mental ability**. Certainly the **human mind is a well-integrated system having a high degree of wholeness**. Wholeness is reflected in complex measures of human ability, which explains the high correlations between standard tests of intelligence. Simpler, more molecular measures should be individually less highly correlated with more complex measures but should provide more specific information about the operation of the system.

Management sciences have learned a great deal about

organizations and how they work. Much of this learning has come from adopting the perspective that organizations are entities (systems, defined later), much like people, plants and animals. There are many benefits to leaders who adopt this systems view of their organizations.

Systems thinking is fast becoming a powerful tool for decision-making and organizational change.

Systems thinking has its foundation in the field of system **dynamics, started in 1956 by MIT professor Jay Forrester.** Professor Forrester recognized the need for a **better way of testing new ideas about social systems**, in the same way we can test ideas in engineering. *Systems thinking allows people to make their understanding of social systems explicit and improve them in the same way that people can use engineering principles to improve their understanding of mechanical systems*.

Systems thinking are fast becoming a **powerful tool for decision-making and organizational change.** All employees in a company should be equipped with the skills necessary for systems thinking. It is imperative to have some awareness of the origin of systems thinking and **how it can be of benefit to various types of organizational change**, *such as reengineering, systems integration, process redesign, Total Quality Management, and teamwork*. In order to apply systems thinking to challenges that occur in the work place, some of the tools and methodologies used in systems thinking should be taught. Some of the best known strategies used to implement systems thinking include systems modelling, simulations, causal loops, archetypes, and scenario planning. To meet the complex changes that are inevitable, systems thinking can no longer be esoteric knowledge held by few managers, but should be accessed by all.

The **approach of systems thinking** is fundamentally different from that of traditional forms of analysis. **Traditional analysis focuses on separating the individual pieces** of what is being studied; in fact, the word **"analysis**" actually comes from the root meaning **"to break into constituent parts." Systems thinking**, in contrast, **focuses on how the thing being studied interacts with the other constituents of the system** – a set of elements that interact to produce behavior – of which it is a part.

The character of systems thinking makes it extremely effective on the most difficult types of problems to solve*: those involving complex issues, those that depend a great deal on the past or on the actions of others, and those stemming from ineffective coordination among those involved*. Examples of areas in which systems thinking has proven its value include:

- **Complex problems** that involve helping many actors see the "big picture" and not just their part of it.
- **Recurring problems** or those that have been made worse by

past attempts to fix them.

§ **Issues** where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment.

System Thinking stresses the systemic pattern of thinking (Systemic is the attribute of thinking derived from systems approach)

Basic Definitions

1.1 Basic Definitions

A system

- **Is an object/process** that has components bound by a mission and has a surrounding environment.
- **Is an ordered, interdependent assemblage of components** in a field that has boundaries defined by a clear mission.

Systems Thinking

- Is seeing through "the system's structure generating changes and creating the problems."
- Is a global way of thinking taking into considerations all factors bounded by the mission of the system.

What is a System?

1.2 What is a System?

Very simply, **a system is a collection of parts** (or subsystems) integrated to accomplish an overall goal (a system of people is an organization). Systems have input processes, outputs and outcomes, with ongoing feedback among these various parts. If one part of the system is removed, the nature of the system is changed.

Systems **range from very simple to very complex**. There are numerous types of simple systems. For example, there are biological systems (the heart, etc.), mechanical systems (thermostat, etc.), human/mechanical systems (riding a bicycle, etc.), ecological systems (predator/prey, etc.), social systems (groups, supply and demand, friendship, etc.) and psychological systems (memory, thinking… etc.).

Complex systems, such as social systems, are comprised of numerous subsystems, as well; These subsystems are arranged in hierarchies, and integrated to accomplish the goal of the system. Each subsystem has its own boundaries of sorts, and includes various inputs, processes, outputs, and outcomes geared to accomplish and overall goal for the subsystem.

A pile of sand is not a system. If one removes a sand particle, you have still got a pile of sand. However, a functioning car is a system. Remove the carburetor and you have no longer got a working car.

1.2.1 Importance of Looking at Organizations as Systems

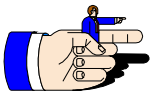
Importance of Looking at Organizations as Systems

The effect of this systems theory in management is that **it helps managers to look at organizations from a broader perspective.** In the past, managers typically took one part and focused on it. Then they moved all attention to another part. The problem was that an organization could, for example, have wonderful departments that operate well by themselves but do not integrate well together; consequently, the organization suffers as a whole.

Now, **more managers are recognizing the various parts of the organization,** and, in particular, the interrelations of the parts, for example, the coordination of central offices with other departments, engineering with manufacturing, supervisors with workers, etc. Managers now focus more attention on matters of ongoing organization and feedback. Managers now diagnose problems, not by examining what appear to be separate pieces of the organization, but by recognizing larger patterns of interactions. Managers maintain perspective by focusing on the outcomes they want from their organizations. Now, manager's focus on structures that provoke behaviors that determine events – rather than reacting to events as was always done in the past.

1.2.2 Systems Theory, Systems Analysis, and Systems Thinking

Systems Theory, Systems Analysis, and Systems Thinking



One of the major breakthroughs in understanding the complex world is systems theory. The application of this theory is called systems analysis. One of the tools of systems analysis is systems thinking. Very basically, systems thinking is a way of helping a person to view the world, including its organizations, from a broad perspective that includes structures, patterns and events, rather than just the events themselves. This broad view helps one to identify the real causes of issues and know where to work to address them.

1.3 Basic Concepts and Characteristics

Basic Concepts and Characteristics

A System

1. **A system**
   - Must have practical boundaries.
   - Can be greater than the sum of its components.
   - Can be closed or open.
   - Must have feedback.

An Open System

2. An Open System

- Must ingest enough input to offset its output and consumption.
- Has no unique solution to the same problem. You need to optimize.
- In effective systems, work adds value and eliminates all sorts of waste.

Systems theory has identified numerous principles that are common to systems, many of which help us to better understand organizations.

Basic principles

Systems thinking reposes on basic principles:

1. Have boundaries

1. **Any system must have boundaries** that separate it from its environment. This principle is essential for studying a system or improving it. If the system is big, it should be broken into subsystems with clear, practical boundaries.

2. Influence behavior

2. **Structures influence behavior**: when there are problems at work, mainly because structure elements do not work together, performance (a result of behavior) fails to live up with what is planned. People tend to react in three different ways:
   - **Addressing systemic structure** because systems generate behavior (generative reaction).
   - **Addressing patterns of behavior** because behaviors produce events (responsive reaction).
   - **Addressing results or events** when they produce (reactive response: most common and the easiest way to react). Addressing structures prevents reproduction of behaviors that result in problematic events. Therefore, to improve a system, consider improving the structure that runs this system.

3. System volume

3. **A system can always be more than the sum of its components.** That a system can always include the effect of synergy. If not, then there is something within not working in harmony with the other components. There is always a position where the function of the system is optimum or effective. This position has to be sought. Effectiveness is not a static property; it changes with change of circumstances and external environment. System effectiveness is apparent when its outputs exceed the sum of the individual outputs. This can be accomplished when there is unity of direction and commonness of objectives of its members and where teams or individuals in the organization see where they stand in relation to the company's other work, especially in cross-functional groups.

   The fact that sum of the system can be greater than the sum of the individual work of its employees, proves that effective systems have synergy. Such state of synergy is reached when waste is minimal, and when all actions add value to the mission of the system.

4. Closed or opened

4. **A system can be considered closed or open at a certain period of time.** An open system has some kind of exchange with the environment. A closed system does not have this exchange: a system in the universe cannot have any exchange with the environment unless for a limited period of time. The car is a closed system, to some extent, when it is parked and not used. When used, the car becomes an open system and exchanges certain product with the environment.

5. Survival of open system

5. **For an open system to survive,** it must ingest enough input from its environment to offset its output as well as the energy and material used in its operation. This is referred to as "steady state." Steady state conditions are dynamic: the system must be able to change in order to adapt to the dynamic situation of the environment of the system. Before reaching a steady state, system can be in a re-enforcement state. Re-enforcement can be positive (if performance is increasing as a result of positive feedback) or negative (when performance is decreasing as a result of negative feedback). Open systems tend to specialize and elaborate their elements and structure and enlarge their boundaries with time, with size and maybe with the change of the environment.

6. no unique solution for open system

6. **In open systems**, there is no unique solution to the same problem: there are many ways to produce the same output or there are many outputs for the same input.

7. feedback

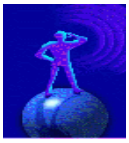
7. **A system must have feedback:** information that the system needs to maintain steady state and to know that it is not in danger of destruction.

8. Cause and effect

8. **In systems thinking**, every influence is both cause and effect: i.e. a cause can also be an effect of something else when regarded in different way.

1.4 Stage of Systemic Thinking

Stages of Systemic Thinking



The Input-Output technique developed by the American General Electric Company can be helpful. Although it need not be, its use has been restricted mainly to technical problems in which the input is energy, light, heat, electricity, etc. - with a desired output in some way dependent upon it. Whiting gives, for example, the problem of devising a fire warning system. The input is fire and the required output a warning that fire is present, with a number of constraints in between: the warning must be foolproof and continuously available; it must be quick-acting to minimize damage; and it must be discernible at points remote from the fire. The problem may not be solved in one step. A warning system requires several intermediate steps, starting with the fire itself and ending with some physical warning system. Whiting warns against trying to short-circuit any intermediate point – this is more likely to lead to a stereotyped solution, since it fails to consider the opportunities for branching into the alternative paths offered by multiple outputs generated at some stages.

Input output principle forms

The Input-Output principle forms much of what might be considered the heart of a 'Systems' approach. This removes the limitations of a problem defined in purely technical terms and extends the definition of input, output and constraints to include the whole situation – men, money, materials, machines and methods. It thereby provides an overall view and allows us to arrive at a more comprehensive, unified and long-lasting solution than any piecemeal approach can make possible.

Applying system approach

Thus, **in applying a system approach**, say, **to a problem involving the manufacture of a chemical,** we would not be limited to the technicalities of the process, choice of materials of construction, design and performance of mechanical and electrical equipment and methods of measurement and control. We should, in addition, be involved with the problems of processing and handling raw materials, methods of transport, and use and disposal of finished products; with the recruitment, training and working conditions of the management and men needed to run the plant; with the effects of the product and its manufacture on the local environment – the noise, smell, smoke and general pollution produced; with the long-term effects of our presence as an employer and a source of opportunity. Even then the list is far from complete, but we are beginning to paint a fuller picture of the total situation and thereby identify more of the important variables having claim to consideration alongside those of technology.

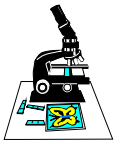
Potential impact on people

Clearly, the more complex a problem and the greater its potential impact on people, the more appropriate a systems approach becomes. But it would surely be wise to consider all but the most narrowly defined technical problem in a context which includes the human element, if we wish to avoid unpleasant reactions and resistance to our solutions when we create them.

Jenkins suggests that there are four main stages in the systems approach: analysis, synthesis, implementation and operation.

Analysis

1. Analysis
What is the problem and how should it be tackled?



What is the nature of the primary system in which the problem is embedded and the wider environment in which it, in turn, is contained?

What are the objectives of these respective levels in the systems hierarchy? Are they stated clearly and are they consistent with each other?

Has all relevant information been collected? Have all constraints been identified (and all false constraints eliminated)?

Synthesis

2. Synthesis

What are the expected changes in the systems under consideration?
How accurate are the forecasts likely to be?

What models can be built of part or the whole of the situation describing behavior, processes, operating conditions, etc.? In what form should these models be – graphical, tabular or mathematical? Can the models be manipulated to simulate changes in the system?

What is the optimum for the whole system? What system is 'best', taking all aspects into consideration with a proper weighting for each? How reliable is this system and what uncertainties remain?

What can be done to ensure that the 'best' system is realized in practice?

Implementation

3. Implementation

Is the final design fully understood, its **implementation adequately planned** and its integration into the wider system properly organized?

Have the design and plan of action been 'sold' to users or operators? Are all changes understood and accepted?

Are there an adequate commissioning plan and a scheme for evaluation performance?

Operation

4. Operation

Have operation and maintenance procedures been prepared and put into use?

Is there a continuing feedback of operating experience to designers and are worthwhile improvements introduced?

Is ultimate obsolescence and replacement catered for?

Techniques of use in such a comprehensive approach include just about every thing in Management Theory, including Critical Examination to get the problem right, Critical Path Scheduling to plan and time the project, Management by Objectives to define the aims of the whole venture and to get people committed, Modeling and Simulation, Risk Analysis, Reliability Studies and Control Systems to aid design.

Development

A useful development of the Systems approach is given by Nadler. He suggests that if we can disengage our thoughts from the present situation when defining a complex problem and think instead

of an ideal solution, that is, one which is not restricted by money, method or resources, then by keeping this ideal solution in mind, we will come nearer to it in practice than by trying to inch forward with the present as our reference point. **Nadler** describes three stages in the achievement of a workable solution: the Ultimate Ideal System, the Technologically Workable Ideal System and the Technologically Workable Ideal System Target. **An Ultimate Idea System** represents the best system likely to be achieved through the development of existing knowledge. But it is achievable, even though at a later date, and can be made a target for improvement in the future, giving a fixed aim point rather than a projection forward from the present situation. **A Technologically Workable Ideal System** is one based on technology which already exists, but which does not take into account real-life restrictions such as money, available skill, etc. By designing several systems to this criterion and selecting one as a guide, a recommended system, the **Technologically Workable Ideal System Target,** as a guide, can finally be described which does take into account all real-life restrictions.

Systems do not have to be complicated

Systems do not have to be complicated or unintelligible, or even dressed in jargon. A system *is just an arrangement of circumstances that makes things happen in a certain way.* The circumstances may be metal grids, electronic components, warm bodies, rules and regulations or anything else. In each case, what actually happens is determined by the nature of the system. One can take the function of the system for granted and become interested in how it is carried out.

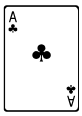
Example

If young children are asked to invent a potato-peeling machine they draw a-winding tube through which a string of potatoes is seen traveling towards a simple box with the explanatory note, 'In here the potatoes are peeled.' Another tube carries the peeled potatoes away. There is nothing mysterious about the box; it just performs the potato-peeling function. One takes it for granted that is the function of the box and that somehow the function gets carried out. In some of the inventions the potatoes are then carried to a metal grid through which they are forced in order to make chips. The making of the chips is not taken for granted but explained, because it is explicable.

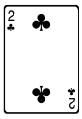
If you put water instead of oil into a frying pan you would not expect to be able to fry chips. If you were to use fat or oil you would get some ordinary chips. If you add a little water to the oil before you put the pan on the fire, then the temperature of the oil will rise more slowly and the chips will be soft on the inside and crisp on the outside - much more so than if only the oil had been used. The nature of the system determines what happens.

The brain is a system in which things happen according to the nature of the system. What happens in the brain is information. And the way how it happens is thinking.

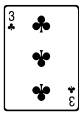
Since thinking in this broad sense determines what people do on any level from the most personal to the most international, it could be worth looking at some aspects of the brain system.



The first useful thing that can come out of knowledge of a system is the avoiding of those errors that arise through thinking the system to be something that it is not.



The second useful thing is awareness of the limitations of the system. No matter how good they may be at performing their best functions, most systems are rather poor when it comes to performing the opposite functions. One would no more go racing in a shopping car than shopping in a racing car. Where one can, one chooses the system to fit the purpose. More often there is no choice, and this means that a single system will perform certain functions well, but others not so well. For instance, the brain system is well suited to developing ideas but not always so good at generating them. Knowing about the limitations of a system does not by itself alter them. But by being aware of the nature of the system one can make deliberate adjustments.



The third way in which one could use knowledge of a system would be to make use of the characteristics of the system to improve its performance or to achieve some end.

How brain system handled information

Some understanding of how the brain system handled information could be very useful. It might then be possible to recognize some of the errors and faults inherent in this type of system, to show, for example, that there was a tendency to arbitrary and self-enhancing divisions which were extremely useful in most cases but could also be the source of a lot of trouble. Apart from becoming aware of the errors of the system, it might also be possible to make more effective use of it through understanding its nature in order to make the learning process easier and more economic. It might be possible to do something about communication.

Language, notation and mathematics

Language, notation and mathematics are useful artificial aids to thinking. There may be other artificial aids which could be invented if one had sufficient understanding of the brain system. With new notation it might prove possible to generate ideas as easily as we now develop them once they have been generated. For instance, it might be possible to invent a new word which would be functional in nature like 'and', 'if', 'but' or 'not. The function of this new word would be to compensate for the inherent limitations of the information - processing system in the brain and open up new ways of talking and thinking. The word would ultimately have to justify its usefulness in practice, but its invention may not have been possible without an understanding of the nature of the system.

Some necessary properties

There are a few necessary properties of systems that need to be stated before proceeding. The most basic of these is that systems exhibit some degree **of stability, or constancy**. If they do not, it would not be possible to identify them as the same system over time. A system may be closed, which means that it is a self-contained, self-regulating entity that is insulated from, and does not interact with, other systems. Or, it may be open, or interactive. For open systems to be stable they must exhibit equilibrium through negative, or compensating, feedback, because if they do not, their form would change and the necessary property of stability over time would be lost. The "hunting" of servo-mechanisms and the homeostasis of vegetative biological functions in animals are examples of open systems maintaining equilibrium through negative feedback.

Individual's psychological resources

The individual's psychological resources for coping with the social world-what we call in everyday terms the person-can be construed as a system in this sense. Analogies with systems in the social sciences usually concentrate on the behavior of thermodynamic systems. *The second law of thermodynamics states that all closed systems are subject to increasing entropy.* The entropy of a system is the measure of unavailable energy; energy that still exists but which is lost for the purpose of doing work. In thermodynamics, of course, the energy referred to is heat and the law can be roughly understood as the idea that all (hot and cold) material within a thermally insulated area will eventually come to have the same temperature. The more general version of this principle is that all closed systems are subject to loss of differentiation. A correspondence has been established between the entropy of a system and the loss of information in that system in the sense of information theory. So, this principle can also be taken to mean that the information in a closed system diminishes over time.

Concept of entropy of living organisms

Schrödinger, applying the concept of entropy to living organisms, writes: "*Thus a living organism continually increases its entropy-or, as you might say, produces positive entropy-and thus tends to approach the dangerous state of maximum entropy, which is death.* It can only keep aloof from it, i.e., alive, by continually drawing from its environment negative entropy".

A closed system

A closed system, in thermodynamics or biology or whatever, like the concept of infinity in mathematics, *is an ideal or pure state, unreal when applied to the physical world.* But although closed systems are probably never perfectly realized in practice, the pure concept serves as a useful anchor for theories in the study of material things. The same is true of the concept of system applied to the social world. Consider, for instance the "ideal" but incredible notion of a person as a closed system, completely insulated from other systems, from the rest of the community. Such insulation would take the form of never talking with anyone and never doing anything (doing, that is, in the sense of acting and choosing as non-automatic, non-habitual justified performance). Borrowing from the thermodynamics analogy, one of

the properties of such a closed person-system would be its increasing entropy; the gradual decline in the harness able energy, or differentiation, or information, within it.

Understanding the Nature of the System in Organizations

1.5 Understanding the Nature of the System in Organizations

Effective leader-managers have a common affinity for understanding the nature of the larger system within which they work. Whenever they take on new job assignments, they make a special effort to understand the inner workings of the larger system of which their work unit is a part. Realizing that the needed information can not be uncovered simply from printed documents; they are relentless in their probing. They observe, inquire, and integrate until they are satisfied that they have a valid conceptual model of the system.

Good judge

John Dewey, the philosopher and educator, **was astute in his portrayal of the "good judge."** This is a person "who has a sense of the relative indicative or signifying values of the various features of the perplexing situation; knows what to let go of as of no account; what to eliminate as irrelevant; what to retain as conducive to the outcome; what to emphasize as a clue to the difficulty." In essence, this is a person who has a profound understanding of the larger system within which he or she works.

Good grasp

In The Human Organization, **Rensis Likert stresses that the manager should have a good grasp of two aspects of the system:** *the nature of the system and the state of the system*. In this regard, he likens the manager's job to that of the physician:

> **A physician needs** two different kinds of **information to make a correct diagnosis. First,** *he must know a great deal about the nature of human beings.* This knowledge is based on extensive research which relates symptoms to causes and measurements of body conditions to the health of the organism, thereby revealing the character of the human body's normal and abnormal functioning. This knowledge gives the doctor insights into how the system ought to function, so that he can know what he needs to measure and how he needs to interpret the measurements. **The second kind** *of information needed by the doctor to discover the patient's state of health at any particular time is that revealed by the appropriate measurements and tests made on that patient at that time*.

Progress measurement

It is generally understood that **measurement of progress is dependent on accurately assessing the state of the system at any point in time.** It also must be understood that accurately assessing the state of the system is dependent on understanding the nature of the system.

Variables to understand the nature of the system

To understand the nature of the system, Likert stresses that the manager must grasp the relations between and among **three types of variables:**

1. Casual

2. Intervening

3. End-results

1. **Causal variables:** independent variables that determine the course of developments within an organization and the results achieved by the organization.
2. **Intervening variables:** mediating variables that reflect the internal state and health of the organization.
3. **End-result variables:** the dependent variables that reflect the achievements of the organization.

Interrelation of variables

As an illustration of how these three classes of variables interrelate, we can consider the example of the effect of leadership style on productivity. In many situations, it would be assumed that a participative leadership style would be more effective than an autocratic style. This premise can be tested by correlating leadership style (causal variable) with employee motivation (intervening variable), and then correlating employee motivation with productivity (end-result variable). In this way it could be demonstrated that leadership style has an effect on productivity, but via employee motivation.

Understanding the nature of the system

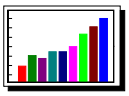
Given this framework for **"understanding the nature of the system**", we will illustrate the notion by considering the dollar flow in a for-profit engineering firm. You may not have any particular interest in an engineering firm, but the principles elucidated here would apply to any type of organization.

The dollar flow of the illustrative firm is shown in Figure 1.1. We will consider the business volume to be the causal variable, the net income to be the end-result variable, and everything else to be intervening variables.

The business volume is broken down into these categories: **labour, use of equipment and service centres, all other project costs, overhead (engineering department overhead, general overhead, and cost of capital), and fee.** The general overhead is apportioned as direct expenses of engineering operations (funds allocated to the engineering departments) and indirect expenses (funds used to operate the company as a whole).

Effective managers needs

Effective managers understand the causal relations in this financial system. For example, they realize that increasing labour (time on projects) by one percent can have at least a 10-percent impact on net income. They realize that a two-percent overrun in project losses can cause a 20-percent decrease in net income. Further, they realize that a fee increase of three percent can have a 30-percent impact on net income. These multiplier effects are indeed noteworthy, and they are ever-present in the mind of the effective manager.



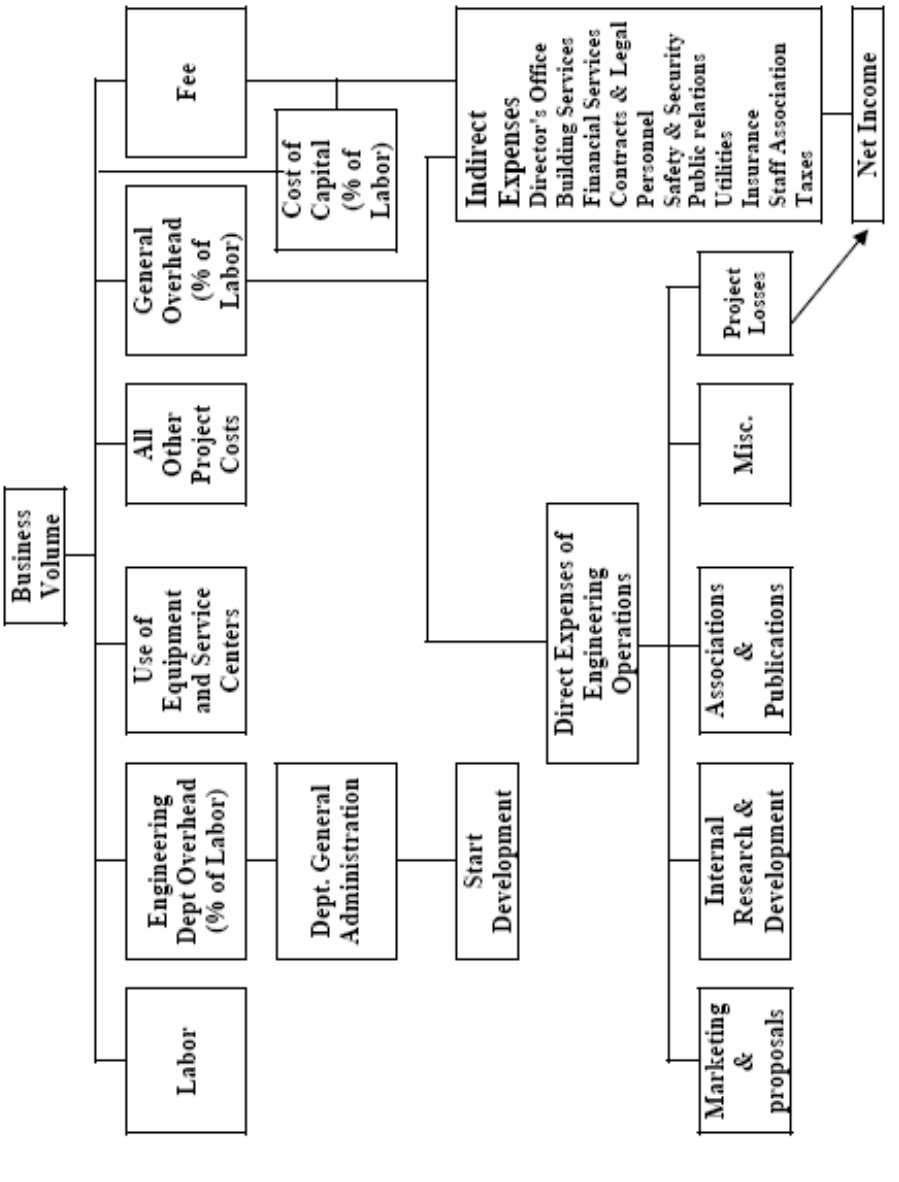


Figure 1.1: Dollar flow in an engineering firm

Important decisions

Managers who understand this financial system also **realize that it presents them with a number of important decisions.** For example, will the return-on-investment with the marketing and proposals funds be better in the industrial arena or in the government arena? With the funds allocated for internal research and development, is it better to invest in a small number of really good ideas or in a large number of possibly promising ideas? With the funds for associations and publications, which particular associations and publications should be pursued? These are important questions, and the answers generated will determine the success or failure of the manager.

Other casual relations

There are **numerous other examples of important causal relations in the system,** but these will illustrate the point that for you to be able to measure your unit's progress, it is essential that you understand the inner workings of the larger system.

Chapter 2: Internal Systems

Function of bio psychological processes and systems

Steps

Referring to **Figure 2.1** we can observe once more the function of bio psychological processes and systems as they occur within human thinking and problem-solving processes - yet another homologous system. The sequence of functions in the stream of consciousness that accompanies mental processing **of a "problem" is represented by the same steps living organisms follow:**

a. **Searching** for available knowledge and information.
b. **Analyzing**, breaking down, and digesting the data.
c. **Manipulating** that information through imagination into new synthesis, into a hypothesis or idea.
d. **Internally projecting** the use of the idea.
e. **Evaluating** the solutions for their "fitness," that is, their potential effect and value and the probable feedback that will be received.

Once this internal system has processed a problem to our satisfaction, we put it into the primary growth system and try it out in the external world. Although we do not know the details of all the internal processes of the cell, we can speculate that this creative internalization confers to the activities of Man a unique advantage - being able to submit a wide variety of growth alternatives to an internalized simulation of evolutionary natural selection process before actually applying it in the real world.

Parallel steps

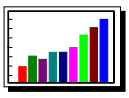
Although we have so far considered the process by which the ectogenetic system of Man came about and how it operates, **some of the parallel steps in the growing organization of information may indeed have created a reconstructed system** even more fundamental than the ectogenes or culture. Because the primary mechanism of biologic endogenetic information accumulation has always occurred by creating mutated nucleotide codes and testing their fitness through natural selection, it is reasonable to imagine that both the external replication of the system through Man's tools and ideas, and the internal structure of the human system operate in an identical way. Man's brain may be, in fact, a miniature evolutionary laboratory.

Take closer look

Brain work

To take a closer look at this concept, imagine that the **brain is a colony consisting of 12 billion cells or so.** *If an "idea" is formed in the mind, it can actually represent the rearrangement, addition, or subtraction of codes among neurons. The neuron does not duplicate itself in the usual way, however. Its propagation and self -verification come about when it is subjected to the environment made up of the other brain cells. The nuclear data making up the coded pattern of*

these cells are the facts, opinions, and perceptions of the external environment, a condensed replica of that believed world. It may very well be that, like the transfer of ***DNA*** *in such operations as temperate phase transduction, the idea attempts to grow in the "culture" by transmitting its code to other cells*. In this process it encounters normal environment pressures. If it fits, it is allowed to grow and affect many parts of the brain. Thus, by successfully propagating in the replica culture, it has been "pretested;" it can change, mutate, and even die within the cerebral system without incurring any gross biologic waste. The brain and the process of thinking may be, in effect, a miniature, accelerated, and magnificently more efficient evolutionary instrument - in quite real organic and biologic terms.



Internal problem solving

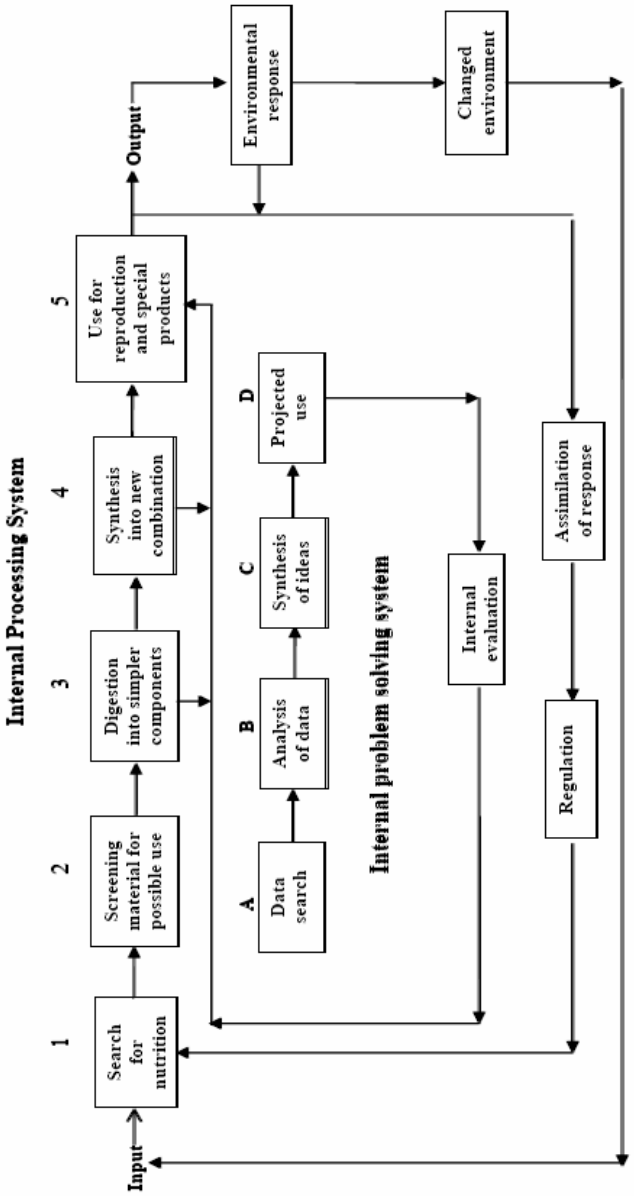


Figure 2.1: Internal problem-solving system

Automatic and autonomic

As an automatic and autonomic "laboratory" of testing reality, the enigma of the unconscious state of dreaming can also be explored within the conceptual framework of transformation. Although we may temporarily sever the connection of our link with external reality in sleep, the process of mutation and selection continues. Deprived of external effect and feedback, however, the brain may react unconsciously in the same way that consciousness operates in sensory-deprivation experiments. After a period of no perception and feedback, even while fully awake, a person will begin to fantasize and hallucinate. The unconscious, while it is attempting to perform normal "problem-solving" or what can be seen as evolutionary activity, may be greatly affected by loss of connection with the outside world.

In practical sense

In a practical sense, *by applying individual experience each of us can observe the evolution, mutation, and selection processes as they go on in our own minds at any time.* The process which Ainsworth-land calls imagination generates mutations with "novelty and diversity"; the function of natural selection or "judgment" is observed as the pressure of facts buffets an idea, allowing it to grow or die inside the mind.

Thinking

2.1 Thinking

Thinking most generally, **any covert cognitive or mental manipulation of ideas, images, symbols, words, propositions, memories, concepts, precepts, beliefs or intentions.** In short, it is a term used so that it encompasses all of the mental activities associated with concept-formation, problem-solving, intellectual functioning, creativity, complex learning memory, symbolic processing, image; etc. These terms in psychology cast such a broad net and few encompass such a rich array of connotations and entailments.

Components

Certain components nonetheless lie at the core of all usages: (a) Thinking **is reserved for symbolic processes;** the term is not used for behaviours explicable by more modest processes such as that of rats learning a simple maze. (b) Thinking **is treated as a covert or implicit process** that is not directly observable. The existence of a thought process is inferred either from reports of the one who was doing the thinking or by observing behavioural acts that suggest that thinking was going on, e.g., a complex problem solved correctly. (c) Thinking **is generally assumed to involve the manipulation** of some, in theory identifiable, elements. Exactly what these "elements of thought" are anybody's (and sometimes it seems, everybody's) guess. Various theorists have proposed muscular components **(Watson)**, words or language components **(Whorf)**, ideas **(Locke)**, images **(Titchener)**, propositions **(Anderson)**, operations and concepts **(Piaget)**, scripts **(Schank)** and so forth. Note that some of

these hypothesized entities are quite elemental and others are quite holistic. No matter, all are serious proposals and all have at least some evidence to support their use in the process of thinking.

Because of the breadth and looseness of the term, **qualifiers are often used to delimit the form of thinking under discussion.** Some of these specialized terms follow; others are found under the alphabetic listing of the qualifying term.

2.1.1 Characterizing Thinking

Characterizing Thinking

The term "thinking" will be **taken as referring to a set of processes whereby people assemble,** use and revise internal symbolic models. These models may be intended to represent reality (as in science) or conceivable reality (as in fiction) or even be quite abstract with no particular interpretation intended (as in music or pure mathematics). Here, we will be mainly concerned with the first case, which is typical in problem -solving. Thinking directed toward problem-solving may be regarded as exploring a symbolic model of the task to determine a course of action that should be the best (or at least be satisfactory). **A symbolic model often enables the thinker to go far beyond the perceptually available information** and to anticipate the outcomes of alternative actions without costly overt trial and error.

2.1.2 Characterizing Problems

Characterizing Problems

Given the strong emphasis on problem-solving in this context and in the general literature on thinking, the question arises **"what is a problem?"** The definition offered by the Gestalt psychologist **Karl Dunker** is still serviceable. He wrote that "a problem arises when a living organism has a goal but does not know how this goal is to be reached".

This is a useful initial formulation that signals a number of points. *First,* *that a "task" set by an experimenter is not necessarily a problem for a given individual. Whether it is a problem or not, depends on the subject's knowledge and on his ability to locate relevant knowledge, should he have it?* ***Second,*** *a problem may vanish or be dissolved if the person changes his goals.* ***A third point*** *is that a problem does not effectively exist until the person detects some discrepancy between his goals and the situation he finds himself in.*

Most psychological studies of problem-solving (especially, as we shall see, those within the information processing framework) have dealt with well defined problems. If we accept **Rittman's** useful proposal that problems in general can be viewed as **having 3 components (viz. a starting state, a goal state and a set of processes that may be used to reach the goal from the starting state)** then a problem is well defined if all 3 components are completely specified. Problems

Defined problem

in mathematics, in logic and in various board games tend to be well defined. **Although well defined, such problems can be very difficult** and the psychologist is faced with the task of explaining how we humans, with our various limitations, manage to solve geometry, chess and similar scale problems in reasonable time. Of course, it will be still more difficult to explain how we tackle those ill-defined problems that are more typical of real life than the well-defined variety.

Undefined problem

Undefined problems leave one or more components of the problem statement vague and unspecified. Problems can vary in degree of defineness an animal.

Handling well-defined problems

It seems a reasonable strategy for psychologists to start with people's ways of **handling apparently well-defined problems** and then move on to consider ill-defined tasks. Perhaps people tackle ill-defined tasks by seeking a well-defined version of the problem, which they then work within until the problem is solved or a new definition is tried. If this is so, then studies with well-defined problems will be relevant to part of the process of solving ill-defined problems. Indeed, processes of defining, or interpreting, the problem are also important in well-defined tasks and some attention has recently been given to task interpretation processes that must play a role in both well- and ill-defined tasks.

2.2 Thinking as a Skill

Thinking as a Skill

1. A matter of intelligence

2. Can be improved by training

You have two choices; **as De Bono Says:**

1. **Thinking is a matter of intelligence.** Intelligence is determined by the genes with which you were born. You can no more change your thinking than you can truly change the color of your eyes.
2. **Thinking is a skill that can be improved by training, by practice and through learning how to do it better.** Thinking is no different from any other skill and we can get better at the skill of thinking if we have the will to do so.

These two opposing views can be combined rather simply.

intelligence like a horsepower of a car

Intelligence is like the horsepower of a car. It is possible that the "intelligence" potential of the mind is determined, at least in part, by our genes. Even so there is evidence that the use of the mind can change the enzyme characteristics just as the use of muscles can change their characteristics.

The performance of a car does not depend on the horsepower of the car but upon the skill with which the car is driven by the driver. So if intelligence is the horsepower of the car, then "thinking" is the skill with which that horsepower is used.

intelligence a potential gift

Intelligence is a potential gift. Thinking is an operating skill. Thinking is the operating skill through which intelligence acts upon experience.

If we pursue the car analogy a little further then we come to two important conclusions:

1. If you have a **powerful car then you need to improve your driving skills.** If you do not improve your driving skills then you will not be able to make full use of the available power. You may also be a danger to others.
2. If you have **a less powerful car then you need to develop a high degree of driving skill** in order to make up for the lack of power.

So those who do not consider themselves to be highly intelligent can improve their performance by improving their thinking skill.

2.3 Critical Thinking

Critical Thinking

There are **a few schools** that do have "critical thinking" **on the curriculum.** Critical thinking is a valuable part of thinking but totally inadequate on its own. It is like the left front wheel on a car: wonderful in itself but inadequate by itself.

Critical thinking perpetuates the old-fashioned view of thinking established by the Greek Gang of Three **(Socrates, Plato and Aristotle)**. This view is that analysis, judgment and argument are enough. It is enough to "find the truth" and all else will follow. If you remove the "untruth" then that is enough.

Kritikos means judge

"Critical" comes from the **Greek word "kritikos"**, which **means judge.** While judgment thinking has its place and its value it lacks generative, productive, creative and design aspects of thinking that are so vital. Six brilliantly trained critical thinkers sitting around a table cannot get going until someone actually puts forward a constructive proposal. This can then be criticized by all.

Many of the present problems around the world persist because traditional education has mistakenly believed that analysis, judgment and argument are enough.

Our success in science and technology comes not from critical thinking but from the "possibility" system. The possibility system moves ahead of our information to create hypotheses and visions. These give us a framework through which to look at things and also something to work towards. Critical thinking does have a part to play because if you know your hypothesis is going to be criticized then you seek to make it stronger. But critical destruction of one hypothesis has never produced a better one. It is creativity that produces the better hypothesis.

Culturally, we desperately **need to break loose of the notion that critical thinking is sufficient.** While we believe this we shall never pay sufficient attention to the creative, constructive and design aspects of thinking.

2.4 Lateral Thinking

Lateral Thinking

Mathematical thinking

The purpose of **lateral thinking is to counteract both the errors and the limitations of the special memory-surface.** The errors may lead to incorrect use of information. The limitations may prevent the best use of information that is already available. Natural thinking has all the errors of the special memory-surface. Logical thinking is used to avoid the errors of natural thinking, but it is limited in that it cannot generate new ideas that make the best use of information already available. **Mathematical thinking avoids the errors of natural thinking by setting up an information processing system that is distinct from the memory-surface.** The limitation of mathematical thinking is that it is only a second stage system which is used to make the most of what has been chosen by the memory-surface in the first stage. None of these three types of thinking can get completely beyond the limitations of the memory-surface, though two of them can reduce the actual errors to a considerable extent.

A problem is simply the difference between what one has and what one wants. Since a problem has a starting-point and an end point, then the change from one to the other by means of thinking is a direct indication of the usefulness of that thinking.

Types of Problems

Types of problem

Require processing of available

Problem of no problems

Solved by re-structuring of information

There are three basic types of problems:

1. Problems that **require the processing of available information** or the collection of more information.
2. The problem of no problem; **where the acceptance of an adequate state of affairs precludes consideration** of a change to a better state.
3. Problems that are **solved by re-structuring of the information** that has already been processed into a pattern.

The **first type of problem can be tackled with logical thinking, or mathematical thinking,** or the collecting of more information. **The other two types of problem require lateral thinking.**

Most of the time the established patterns on the special memory surface are improved only by information which comes in from outside. It is a matter of addition or gradual modification.

Lateral thinking is more concerned with making the best possible use of the information that is already available on the surface than with new information, see Figure 2.2.

Lateral Thinking

Lateral thinking is concerned with compensating for the deficiencies of the special memory-surface as an information-processing device. Lateral thinking has to do with rearranging available information so that it is snapped out of the established pattern and forms a new and better pattern. This rearrangement has the same effect as insight. The established patterns which determine the flow of thought can be changed by lateral thinking, as can the established patterns which control how things are looked at.

The memory-surface itself, natural thinking, logical thinking and mathematical thinking are all selective processes. The memory surface selects what it will pay attention to. Natural thinking selects a pathway according to emphasis. Logical thinking blocks pathways according to the mismatch reaction. Mathematical thinking uses the rules of the game to select possible changes. The only generative process involved is the chance arrangement of information in the environment.

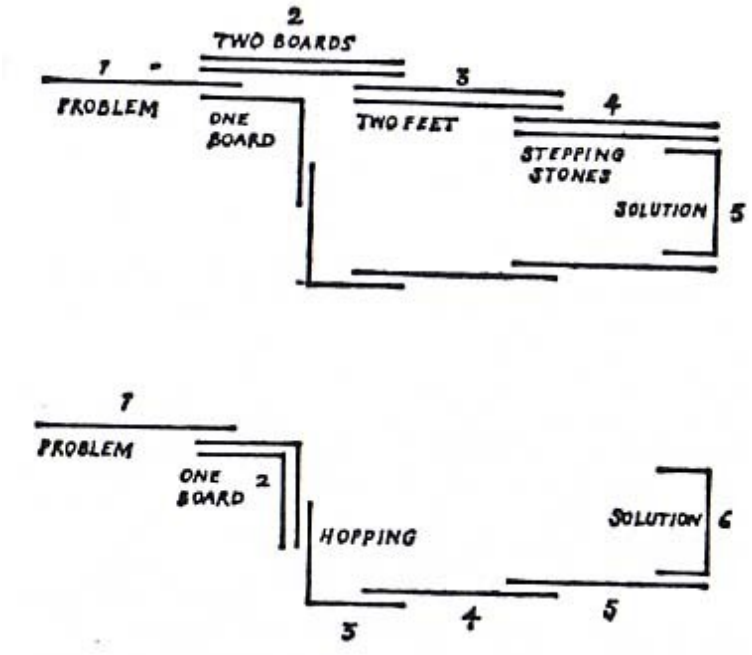
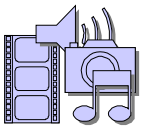


Figure 2.2: Lateral thinking

A baby crying is a generative situation. The baby just makes a noise and then things happen. From all the things that happen, the baby accepts the ones that are useful to it. Lateral thinking is a generative process. Instead of waiting for the environment to change established patterns, these are deliberately disrupted in various ways

so that the information can come together in new ways. If any of these new ways are useful, then they can be selected out by any of the selecting processes.



In the early days of photography, **the photographer used to go to a great deal of trouble to arrange the background, the lighting, the pose, the smile, and then when everything was just right he took the photograph.** Nowadays the photographer just takes dozens of pictures from different angles with different expressions and different lightings. Then he develops all the pictures and picks out the ones that look best. In the first case the selection is done before the photograph is taken, in the second case it is done after the photographs have been taken. The first method will only produce what is known beforehand and planned. But the second method may produce something new that was totally unexpected and could never have been planned.

With the other types of thinking you know what you are looking for. With lateral thinking you may not know what you are looking for until after you have found it. Lateral thinking is like the second method of taking photographs, and the other sorts of thinking are like the first method. For convenience these other sorts can be included under the heading of vertical thinking which is the sequential development of a particular pattern - like digging the same hole deeper. With vertical thinking one moves only if there is a direction in which to move. With lateral thinking, one moves in order to generate a direction.

The generative effect of lateral thinking is exerted in two ways. The **first way is to counteract, restrain or delay the fierce selective processes of the memory-surface itself.** It is also necessary to counteract the selective processes that have been artificially developed, such as logical thinking with its heightened sensitivity to a mismatch. **The second way is to bring about deliberate arrangements and juxtapositions of information that might never otherwise have occurred.** The aim of both these processes is to allow information to arrange itself in new and better patterns, as happens in insight.

The nature of lateral thinking may be illustrated by outlining a few specific points of difference from vertical thinking.

Alternatives

Alternatives

The special memory-surface is a self-maximizing system. The tendency of such a system is to select the most obvious approach provided this is adequate. In an experiment, **a group of children were each given two small wooden boards.** There was a hole in the end of each board, and the children were also given a piece of string. The task was to cross the room as if it were a river by somehow using the boards so that no part of the body touched the

ground. Because there were two boards and they had two feet the children soon hit on the idea of using the boards as stepping stones. They stood on one board and moved the other ahead and then stepped on that and moved the first board ahead. This was an effective way of getting across the room.

A second group of children were only given one of the boards and the piece of string. After a while a few of them tied the string to the hole in the board. Then they stood on the board and holding it up against their feet with the string they hopped across the room. This was a much better way of getting across the room than the stepping stone method. But the children with two boards were completely unable to find this solution since they were blocked by the adequacy of the other solution.

An approach may choose itself because it is obvious, or it may be the only one left after other approaches have been blocked with a no label.

With vertical thinking, an approach is selected in either one of these two ways. With lateral thinking, as many alternatives as possible are generated. One disregards the no reaction since so often it is applied prematurely. One may recognize the obvious approach but never the less go on generating other ones as well.

Non-Sequential

Non-sequential

There may be no reason for saying something until after it has been said. Once it has been said a context develops to support it, and yet it would never have been produced by a context. It may not be possible to plan a new style in art, but once it has come about it creates its own validity. It is usual to proceed forward step by step until one has got somewhere. But it is also possible to **get there first by any means and then look back and find the best route**. A problem may be worked forward from the beginning but it may also be worked backwards from the end.

Instead of proceeding steadily along a pathway one jumps to a different point, or several different points in turn, and then waits for them to link together to give a coherent pattern. It is in the nature of the self-maximizing system of the memory-surface to create a coherent pattern out of such separate points. If the Pattern is effective then it cannot possibly matter whether it came about in a sequential fashion or not. A frame of reference is a context provided by the current arrangement of information. It is the direction of development implied by this arrangement. One cannot break out of this frame of reference by working from within it. It may be necessary to jump out, and if the jump is successful then the frame of reference is itself altered.

Quota

Quota

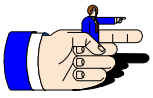
It is quite easy to **set up a fixed quota of alternative approaches** that must be found for any problem. No one approach is followed until the quota has been filled. This procedure will not itself generate new approaches but it will keep attention at the starting point instead of letting it be led away by the first promising approach to the extent that other approaches are never looked for.

Rotation of Attention

Rotation of Attention

If one divides the situation into parts then it is possible to **have a deliberate technique which requires that each part in rotation** becomes the centre of attention. Once again this is a delaying technique to prevent attention being monopolized by the most dominant feature.

Reversal



Reversal

This involves **taking something and turning it upside down**. Where one direction is defined then the opposite direction is also defined by implication.

In a winding country lane a motorist came up behind a slow moving flock of sheep which filled the lane from side to side. The lane was bounded by high walls with no gap and the motorist was resigned to a long wait. Then the shepherd signaled the motorist to stop, and proceeded to turn the flock round and drive it back past the stationary motorist. It was a matter of getting the sheep past the car rather than the car past the sheep.

Cross-fertilization

Cross-fertilization

This is a matter **of providing a formal opportunity for different minds to interact** so that differences in thinking about a subject act as outside influences to change the established patterns in each mind. What is established in one mind may be novel in another. Ideas spark off other ideas.

Conclusions

Conclusions

These are a few of the formal techniques that can be used in lateral thinking. The techniques provide **special opportunities for lateral thinking processes to occur on the memory-surface.** Just as a scientific experiment is a designed opportunity for information to become manifest, so the formal techniques are opportunities for information to become arranged in new patterns. The patterns will be different, some of them may be better.

Lateral thinking is a generative type of thinking. Once a new arrangement of information has come about then it can he examined by the usual selective processes. Lateral thinking as a process can never justify the outcome, which has to stand by itself. Lateral thinking in no way detracts from the efficiency of vertical thinking. On the contrary, as a generative process it can only add to the over-all effectiveness of any selective process.

It sometimes happens that **lateral thinking can provide an insight rearrangement of information that by itself solves the problem.** At other times lateral thinking provides an approach for vertical thinking to develop.

Late twentieth-century neuropsychological theory suggests that **the human forebrain can best be considered as a limbic system and a frontal neocortex.** The limbic system is the seat of the emotions; it deals with the non-rational. In contrast, the neocortex is the thinking brain, but is itself divided into lateral hemispheres with rather different functions, see Table 2.1. In short, the left hemisphere is Apollonian: verbal, mathematical, logical, deductive, and oriented towards the external environment ('outward bound'), whereas the right hemisphere is Dionysian: holistic, intuitive, spatial, pattern-recognizing, and concerned with inner spaces ('Inward bound').

Table 2.1: Left-and right-brain functions

Left hemisphere	Right hemisphere
• verbal language • detail • linear • manipulative • orthodox • behavioral (do) • rational (scientific) • analytical (tree) • departmentalizes • form (spherical ball) • concrete (a shoe is a shoe) • tangible (seeing is believing) • time (next thing to do)	• eidetic (image) language • pattern recognition • geometric, three-dimensional • reactive • creative • experiential (feel) • emotional (artistic) • synthetical (forest) • emphasizes relationships • color (blue ball) • associative (a shoe: let’s walk) • intuitive (that’s possible) • space (enjoy where you're at)

Brain and Thinking

2.5 Brain and Thinking

A scientific field of study that helps us to distinguish the functions of the brain from those performed by the mind is hemisphere specialization. Launched in the early 1960s at the **California Institute of Technology** by psychologist **Roger Sparry** and his associates, the field has advanced enormously with vigorous neurophysiological and split brain studies that use computer correlated psychophysiological measuring techniques. Today, all major research works in visual communication media related topics for example, acknowledge the findings in the field of hemisphere specialization, particularly those related to the recognition and aesthetic effects of moving images. In visual learning the discussion of left and right brain recognition of moving images is very important because the composition of visual images is directly related to brain specialization.

Left and Right Brain Decodification of Visuals

2.6 Left and Right Brain Decodification of Visuals

The brain has two hemispheres connected with fibbers in the corpus callosum. *If the corpus callosum did not exist, or if it was surgically severed, visual and auditory information input from the left eye and ear would reach only the left hemisphere, and vice versa,* as the optic and acoustic chiasma that allows the criss-crossing of the information reaching the brain would no longer exist.

Extensive correlated studies that started with brain surgeries mostly on epileptic patients **and the latest neuroanatomical and neurophysiologic ones** that use deoxyglucose to identify which part of the brain is more active have confirmed that recognition of images is a function of the right brain.

Underlining the tasks of the right brain, ***Ornstein*** *stated that: If the left hemisphere is specialized for analysis, the right hemisphere seems specialized for holistic mentation*. Its language ability is quite limited. This hemisphere is primarily responsible for our orientation in space, artistic endeavour, crafts, body image, and recognition of faces. It processes information more diffusely than does the left hemisphere and its responsibilities demand a ready integration of many inputs at once. If the left hemisphere can be termed predominantly analytic and sequential in its operation, then the right hemisphere is more holistic and relational and more simultaneous in its mode of operation.

Image recognition is a function of the right hemisphere of the brain that controls the left side of the body. Pictures are typically images of objects of the real world. Consequently, picture recognition is a function of the right hemisphere of the brain. Recognizing a television picture that combines visuals, sounds, and motion is a

holistic process, a task performed by the right brain.

The Rational Left and the Holistic Right Hemispheres of the Human Brain

2.7 The Rational Left and the Holistic Right Hemispheres of the Human Brain

The number of scientific studies on the left and right brain specialization is immense, and the range of the fields of study of brain specialization-related investigation is large. **An impressive list of such findings illustrating the two modes of operation of the brain was provided by Nevitt.**

The left brain is occidental, whereas the right brain is oriental. The logical brain recognizes objects and events sequentially and logically. Watching the news delivered by a newscaster without distracting visuals in the background is an occidental function of the left brain that controls the right visual field. However, watching a scene described by a newscaster off camera is an oriental activity of the right brain that controls the left visual field.

The left brain specializes in visual speech and recognizes all activities involving language, logic, and words, whereas the right hemisphere is predominantly musical and acoustic and recognizes more readily melodies and musical tunes. Because of this dichotomy of the brain's functions, speeches on television tend to be monotonous and boring, whereas musical concerts, even when filmed by one camera on a long shot, are interesting to listen to and easier to watch.

Charts, maps, numerical figures, tables, statistics, lists of names, numbered items, and mathematical computations are more readily recognized by the left hemisphere of the brain, found to be specialized in logical, mathematical, intellectual, sequential, and analytic functions.

Complex visual elements and multilevel action scenes placed on the viewer's left side of the screen are recognized by the holistic, simultaneous, intuitive or creative, and synthetic right hemisphere of the brain.

Constructors of television programs that consist primarily of scenes requiring a linear and detailed controlled approach such as instructional or educational programs, cooking shows, and language instruction, should consider placement of such activities on the right side of the screen to be recognized by the left side of the viewers' brain. However, those producing television programs consisting for the most part of scenes with artistic, symbolic, simultaneous, emotional, and intuitive content (such as experimental television programs, music videos, art shows, and religious programs) should consider placement of the main activities on the left side of the screen

for better recognition by the right hemispheres of viewers' brains.

All quantitative activities encompassing the action of a television program such as the recognition of complex motor sequences and significant order, reading, writing, numbering, and analyzing should be placed on the right side of the screen to be more readily recognized by viewers' left hemispheres.

On the other hand, all qualitative activities that characterize the action in a television program such as recognition of complex figures, abstract patterns, or scenes requiring simultaneous comprehension, synthesis, and configurations, have a better chance of being recognized if placed on the viewers' left side of the screen.

Perception and Attention

2.8 Perception and Attention

Understanding the value of knowledge and the context in which it is used is an important step in learning about human cognition. Nowhere are the roles of knowledge and context clearer than in human perception.

The process by which meaning is assigned to stimuli **is referred to as perception.** *Perception is critical to all aspects of cognition and is itself directly influenced by the person's knowledge and the context of events created by his or her knowledge.* Closely related to perception is attention, the allocation of a person's cognitive abilities. As your read this page, you also may be listening to the radio. What you perceive at any given moment depends on how your attention is divided among various tasks. If most of it is devoted to a weather forecast on the radio, you may not correctly perceive the meaning of some of what you are reading. On the other hand, if you are immersed in this subject, you may not hear your name when the radio announcer calls it and says that you have five minutes to phone to collect a $1,000 prize.

Perception

2.9 Perception

Let's think for a moment about what is required for perception the assignment of meaning to incoming stimuli to occur**, First,** some aspect of the environment-some stimulus has to be picked up by the person (e.g., has to be seen). **Next,** that stimulus has to be transformed and held, somehow. A body of knowledge has to be available and brought to bear on the stimulus (e.g., cat, cut, and cot are the three-letter words beginning with c and ending with t). **Finally,** sonic decision has to be made-a meaning must be assigned (It's an "a").

The very common phenomenon of identifying the letter "a" seems far more complex when we consider what may happen during the process of perception. One important observation is the fact that perception takes time-identifying the "M" figure (or any other stimulus, for that matter) is not instantaneous. Recall that the stimulus must be picked up and transformed, memory must be called up, the stimulus must be compared to what is in memory, and a decision must be made. The fact that perception requires time leads to a problem of sorts. Because environments may change rapidly (as when watching a film or driving a car), a stimulus could stop being available before a meaning was assigned. (Imagine seeing the word: *DOOR projected by a slide projector for, say, one tenth of a second.) Unless there is some way in which we can "hold" that stimulus for a while, our perceptual processes would have to stop in midstream.* The experience of watching a movie, for example, would be terribly frustrating if stimulus after stimulus disappeared before we could interpret their meaning. Our experience, however, tells us that such breakdowns in our perceptual processes occur infrequently. This is because our cognitive systems are equipped to register sensory information.

Sensory Registers

2.10 Sensory Registers

One of the capabilities of our cognitive system is that it can temporarily retain environmental information after it has disappeared. Apparently, each of our senses has this ability, a sensory register, but research has focused almost entirely on vision and hearing. Here we discuss the visual and auditory sensory registers.

Chapter 3: Memory

Structures and Models

3.1 Structures and Models

Depending on the moment, our memory the register of our experiences - *can be a source of frustration, of pain, of delight, or of wonder.* When we want to access it, often we cannot. Sometimes, when we wish memories would fade, they will not. At unaccountable moments, sweet dreams may find their way into our consciousness. Now and then, our sure recall of figure or fact may allow us to act with uncommon confidence and authority.

For as long as we have thought about **"human nature,"** that aspect called **"memory" has intrigued us**. The scientific study of memory is a recent matter, however, tracing back only a little more than a century to the beginnings of psychology as a systematic, experimental science.

The tradition of memory research first begun by **Ebbinghaus** dominated the study of memory for nearly a century (1850-1909). In general, this tradition was based on the **following assumptions***: (1) that words were the primary mental units of language, (2) that when units were used together they became linked and were chained into larger units, (3) that complex behaviours and patterns of thought were assembled from simple units, and (4) that the mechanisms that produced learning and memory largely were automatic.*

Today, however, our conception of what constitutes the valid study of memory has been broadened considerably. **Memory theories** based on rote memorization and extrapolation of basic principles from simple to complex behaviour largely have been supplanted by those that have attempted to describe complex, meaningful cognitive processes more directly. In the past three decades, especially, memory theorists have made immense strides in describing the nature of knowledge and in developing theories that permit predictions about the nature of learning, memory, and utilization of meaningful information.

Fundamental Distinctions in the Study of Memory

3.2 Fundamental Distinctions in the Study of Memory

As cognitive theorists began more and more to grapple with issues in the learning and recall of meaningful materials, they quickly faced questions about the nature of knowledge and how it is stored in

memory. **Are there basic differences, for instance, between "knowing" something and "knowing how to do" something?** *Does personal experience lead to different storage and retrieval than the more abstracted general knowledge of, say, subject areas such as history and chemistry?* Is memory for language different than memory for images? Are there differences between memory for events just experienced and those experienced some time in the past? **Questions such as these have led to a number of distinctions.** Among the most useful and enduring have been those between *episodic and semantic memory, between declarative and procedural knowledge, between language-based and imagery-based systems in memory, and between short-term and long-term memory*.

Episodic versus Semantic Memory

3.2.1 Episodic versus Semantic Memory

In proposing a distinction between episodic and semantic memory, **Tulving** argued for the utility of distinguishing between the traces of personal experience, on one hand, and general knowledge, on the other. Specifically, **episodic memory refers to storage and retrieval of personally dated, autobiographical experiences.** *Recall of childhood experiences, recollection of the details of a conversation with a friend, and remembering what you had for breakfast all would fall within the realm of episodic memory.* **The critical feature of episodic memory is the existence of a "personal tag",** and the basis for retrieval is an association with a particular time or place. Obviously, a great deal of what we must recall in order to function effectively in our daily lives is of an episodic nature.

Semantic memory, in contrast, **refers to memory of general concepts and principles and their associations**. Unlike episodic memory, semantic memory is not linked to a particular time and place. In our semantic, memory is such information as the fact that lemons are yellow and that computers contain chips. *Semantic memory contains the organized knowledge we have about words and concepts and how they are associated.* For instance, a subject area such as Egyptian literature or American history represents a vast body of semantic information that we (as we become more expert in the area) encode, organize, and have available for retrieval. Recalling word meanings, geographic locations, and chemical formulas similarly requires searches of semantic memory.

Although the psychological validity of the episodic-semantic distinction has been criticized, it continues to be useful in helping us think about the different types of information we must remember. On one hand, the episodic aspect of our memories must function well enough for us to locate ourselves in time and space and have a reasonably accurate record of our experiences. At the same time, we have to have available a general knowledge base in order to think and reason effectively. *Of course, the episodic-semantic distinction*

does not presuppose two physically separate systems in the brain, but rather is a conceptual distinction useful to researchers and practitioners.

Declarative versus Procedural Knowledge

3.2.2 Declarative versus Procedural Knowledge

A second important distinction in the study of memory is between declarative and procedural knowledge. **Declarative knowledge is knowledge about facts and things,** knowledge that something is the case. In contrast, **procedural knowledge is knowledge about how to perform certain cognitive activities**, such as reasoning, decision making, and problem solving.

Declarative memory

Declarative memory

The memory associated with cognitive skills not directly attributable to muscular or glandular responses. The complete memory may be acquired through a single exposure, but practice is beneficial. Declarative memory is required to recall factual information, and it is sometimes called fact memory. The ability to recognize a face, recall a number, or recall any verbal or sensory information requires declarative memory.

One important use for the **declarative-procedural distinction is to describe the kinds of learning students may achieve.** A novice student in a teacher education program, for instance, may memorize principles of classroom management (e.g., "Allow students to make value judgments.") as declarative knowledge, but he may have little or no notion of how these principles actually would be used in effective teaching (procedural knowledge).

Although it has not been described with the terms declarative knowledge and procedural knowledge, the declarative-procedural distinction has been implicit in the work of a number of learning theorists-for instance, in the work of **Benjamin Bloom** and his associates. In Bloom's analysis, for instance, a contrast was drawn between **lower levels of learning** (i.e., knowledge, comprehension), in which facts, concepts, and rules are learned and understood, **and "higher-order" learning** (i.e., application, analysis, synthesis, and evaluation), in which knowledge is used as part of higher level cognitive processes.

Of course, not all procedural knowledge is "higher-order" knowledge based on more fundamental declarative knowledge. Procedural knowledge can be quite simple and only implicitly linked with declarative knowledge. *A young child, for instance, who remembers how to unlatch the door, turn off a faucet, brush her teeth, and open a*

book, is showing her recall of procedural knowledge.

Also, procedural knowledge often is **"automated"** we often begin **"doing" without any apparent conscious attention** to what we are doing or why we are doing it. In a lecture class at a university, for example, most students will enter the class, find a seat, take out a notebook, and begin taking notes with little or no conscious attention to the task. Similarly, as we read, decoding words and comprehending the meaning of what we are reading ordinarily occurs quite automatically. Sometimes, however, our searches of declarative knowledge come at least partially under conscious control. ("Who is the author of *Hamlet*?")

In most learning, of course, **there is interplay between declarative and procedural knowledge.** A concert pianist learning a new song by **Domenico Scarlatti**, for instance, may search her memory for declarative knowledge about that composer's preferred method of executing certain embellishments such as the appoggiatura, mordent, and trill-declarative knowledge that will be utilized in the development of procedural knowledge. **Conversely, procedural knowledge has undeniable impact on declarative knowledge**. Like most experts, our pianist has procedural knowledge about how she best recalls information about composers and their works and will search her declarative knowledge accordingly. Yet another cluster of procedural knowledge-her skills in performing-enhances and gives substance to the declarative knowledge she possesses (e.g., "Scarlatti intended for the mordents to be played according to the basic tempo of the passage. That would mean that they should be thirty-second notes here.")

In **most school learning**, similarly, there will be **goals** for the acquisition of both **declarative and procedural knowledge**. *One important goal of education is the development of relatively large, stable, and interrelated sets of declarative knowledge.* As educators, we expect students will be "knowledgeable". At the same time, however, we place a considerable premium on knowing "how to." For the practitioner, usable knowledge is critical. Especially in applied programs such as journalism, architecture, teaching, management business, and medicine, procedural knowledge is an important outcome of the educational process.

3.2.3 Verbal and Imaginal Representation in Memory

Verbal and Imaginal Representation in Memory

"A picture is worth a thousand words." Although the validity of this aphorism may be debatable, there is little doubt that we humans have extraordinary capabilities for remembering information about visual events. There is little doubt that pictorial information can be represented in our memories quite well. **Certainly,** our subjective experiences would tell its so. Most of us easily can conjure up an image of a book, a soaring bird, a train wreck, or a walk in the woods.

One of the main contributions of cognitive psychology has been a revitalization of interest in the study of mental imagery. Once largely banished from experimental psychology as subjective, mentalistic, and therefore unscientific, imagery has become a significant feature of the work of a number of cognitive psychologists.

One such psychologist, **Alan Paivio**, has proposed **that information can be represented in two fundamentally distinct systems**, **one** suited to verbal information and the other to images. The verbal coding system is adapted for linguistically based information and emphasizes verbal associations. According to Paivio, words, sentences, the content of conversations, and stories are coded within this system. **In contrast**, nonverbal information is stored within the imaginal coding system. Pictures, sensations, and sounds are coded here.

Paivio's theory has been called a dual coding theory, in that incoming information can be coded within one or both of the systems. Although the systems are separate, they are strongly interconnected in their impact on the recall ability of information. To the extent that information can be coded into both systems, memory will be enhanced, whereas information coded only in the verbal system or imaginal system will be less well recalled. In **Paivio's view**, the verbal and nonverbal codes basically are functionally independent and "contribute additively to memory performance". **Paivio** also hypothesizes that nonverbal components of memory traces generally are stronger than verbal memories.

Much of Paivio's early work was devoted to demonstrating the effects of the abstractness of materials on its memorability and relating these results to dual coding theory. For instance, some words (bird, star, ball, and desk) have concrete referents and presumably are highly imaginable. Thus, when presented with such words, both the verbal (e.g., the linguistic representation of the word bird, its pronunciation, its meaning) and the imaginal (an image of a bird soaring) representations are activated simultaneously. Other words, however, are more abstract and far less readily imaginable (e.g., aspect, value, unable). These words, although they activate the verbal coding system, are hypothesized to activate the nonverbal system only minimally. In Paivio's view, memory for abstract materials should be poorer since such materials are represented only within a single system. Pictures, since they tend to be automatically labeled, should be more memorable than words because, although pictures are automatically labeled (and hence dual-coded), words, even concrete ones, are not necessarily automatically imaged.

In a large number of studies, **Paivio** and his associates have demonstrated the beneficial effects of imagery on learning and memory, consistent with his predictions. Words rated high in imagery have been shown to be better remembered in free recall, in serial learning

(where a series of words must be recalled in order), and in paired-associate learning (in which the "associate" of a word must be recalled when the word is presented). Similarly, instructions to subjects to "form images" also have been shown to enhance memory.

Mental Rotation

3.3 Mental Rotation

An intriguing set of studies carried out by **Roger Shepard** and his associates has provided additional information about **the nature of mental images,** their distinctiveness from verbal information, and the role they play in cognition. In an early study, **Shepard** had subjects think about such questions as the number of windows in their house. **He noted that the time required to produce an answer increased with the number of windows counted**, consistent with the idea that individuals actually were mentally manipulating some sort of image. Further, subjects described themselves as taking a **"mental tour"** of their house in order to respond to this question. At least subjectively, there was a strong impression of mentally picturing - looking at or scanning - images.

In a later series of studies, Shepard and his co-workers showed that **mental images generated by persons underlie a number of cognitive operations.** In one set of studies, for example, persons were asked to judge whether three-dimensional objects presented in different orientations were identical; see Figure 3.1. The fascinating result was that the time required to make the judgments increased linearly with the extent of rotation required. That is, it appeared that persons were mentally rotating the objects in order to make the comparison; the greater the rotation, the longer it took to make a judgment.

More recently, **Stephen Kosslyn** and his colleagues have demonstrated other interesting effects. For example, in one study, persons were asked to memorize a map of an island on which such objects as a tree, rock, or hut were depicted at varying locations; see Figure 3.2. After the map was committed to memory, they were asked to focus on a named object on the map. They then were given the name of a second object and told to locate it by imagining a black speck moving in a straight line from the first object to the second. Objects were, of course, varying distances from one another on the map. If the mental image is being scanned, as **Kosslyn** hypothesized, then time required to move from one object to the next should vary directly with the distance on the image. In fact, this was what **Kosslyn and his associates** found**. "Distant" objects took longer to reach than "near" objects,** demonstrating that images, like pictures, contain information about the spatial relations among objects.

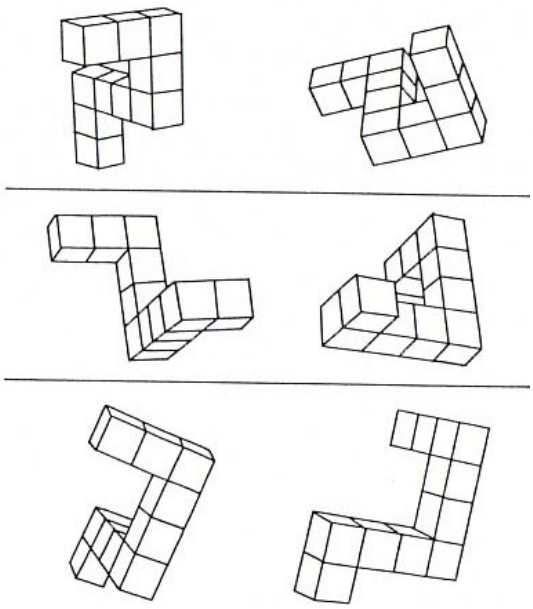


Figure 3.1: Pairs of patterns with different orientation.

These pairs of figures are similar to those used by Shepard and Xletzler (1971) in their study of the mental rotation of three-dimensional objects.

Figure 3.2: An island map.

Using persons' ability to form images of different sizes (e.g., a large rabbit versus a very tiny rabbit) and at different locations (e.g., nearby versus far away), **Kosslyn** also has shown that **when persons are asked to verify certain features of mental images** (e.g., "Do rabbits have whiskers?"), **details of "small" images** (e.g., a small rabbit) **take longer to verify than those of "large" images** (a large rabbit). According to Kosslyn, such evidence points to the conclusion

that **images have a "grain" or resolution.** Thus, portions of images visualized as subjectively smaller actually make details harder to discern.

3.4 Short-Term versus Long-Term Memory

Short-Term versus Long-Term Memory

Beginning in the late 1950s and increasing rapidly thereafter, the research journals in learning and memory began to be flooded with research on a new topic. **What was being studied and reported on was not a new phenomenon, but a new dimension of the already well studied area of human memory.** The new dimension being investigated was the nature of **memory over very short intervals-seconds or minutes.** The name given to this phenomenon was **short-term memory, or simply STM**.

Memory theorists long had proposed that **there may not be one, but two, mechanisms for memory storage**. What they suggested was that **one type of storage mechanism is available for events recently experienced.** This mechanism is the realm of STM. Another type of storage system seems to exist, however, **for traces of experiences developed over longer periods through repetition, habit, and study.** This aspect of memory is called long-term memory, **or LTM.**

Several differences between STM and LTM were hypothesized. **First,** it was contended that STM involves "activity" traces in contrast to LTM's "structural" traces. That is, STM is dependent on ongoing electrochemical brain activity; in contrast, LTM is based on relatively permanent changes in brain cell structure. **Another**, related contention was that STM decays autonomously, whenever attention is diverted from what is to be remembered. LTM, however, is based on irreversible, non-decaying traces. **Third**, obvious differences in capacity between STM and LTM were noted. Whereas STM has relatively fixed limits, LTM was judged to have apparently unlimited capacity.

These distinctions match well with our own introspective assessment of our memory capabilities. For instance, when we encounter new information, we generally need to continue to pay attention to it and rehearse it in order to **"keep it in mind." Remembering a phone number** we have just looked up or the names of several new acquaintances, for most of us, **requires some attention and repetition**. Especially on first encounter, our memory for such information can be exceedingly fragile-even a brief interruption or distraction may cause us to loose the thought entirely.

Once information has been well learned and committed to memory, however, rehearsal and repetition seem much less critical. We easily can state our uncles' names, recall the names of

two large cities on the Red Sea, or give three examples of large hairy animals without having to rehearse any of this information-despite the fact that we may not have thought of these topics for months or even years!

In more recent models of memory, however, **the importance of the STM-LTM distinction has diminished.** Although memory theorists have continued to pay attention to the differences between STM and LTM, most models of memory have shifted from storage to a **"processing"** emphasis. This processing emphasis is retained in most current models. Rather than being conceived of as a "place" where information is held for brief periods, the concept of STM has been broadened so that it reflects the many different ways in which we deal with information. The STM now more and more reflects the concept of "working memory"-that part of our cognitive systems we would refer to as our consciousness. For example, **J.R. Anderson's ACT model incorporates a "working memory"** and a long-term memory." These two are not emphasized as "separate places," however, but rather as being closely interrelated. The current contents of consciousness set up a pattern of activation in LTM; this activation of LTM, in turn, may "reverberate" back into working memory.

3.5 Concepts

Concepts

One of the major ways in which we deal with the bewildering array of information in the world is **to form categories**. Our language mirrors these categories-the words grandfather, data, bird, psychology, red, dog, and man each represent a category meaningful to most of us. **Concepts** are the mental structures by which we represent these categories. **Particular objects or events** are grouped together based on perceived similarities; those that "fit" the category are examples or instances of the concept; those that do not are non examples. **The similar features across examples of a concept** (e.g., all oceans contain water and are large) are called attributes; features essential to defining the concept **are called defining attributes**. Learning concepts involves discovering the defining attributes along with discovering the rule or rules that relate the attributes to one another.

The work of **Bruner** and others has shown that individuals typically solve concept identification problems by trying to discover the rules relating the concept attributes. In general, **concepts that have more difficult rules are more difficult to learn. The simplest rules involve affirmation** (e.g., any green object) and **negation** (e.g., any object that is not green), which apply if there is only one attribute being considered. *Most concepts, however, involve more than one relevant attribute and hence more complex rules. Among the most common are conjunctive rules, in which two or more attributes must*

be present (e.g., any triangle that is green), and disjunctive rules, in which an object is an example of a concept if it has one or the other attribute (e.g., either a triangle OR a green object).

In recent years, **Bourne's work** has represented the clearest statement of rule-governed conceptual structure. In his view, concepts are differentiated from one another on the basis of rules such as the above. **These rules provide the means for classifying new instances as either linked to a concept or not**. According to Bourne, membership in a conceptual class (e.g., grandfathers, data, and birds) is determined by applying a set of rules. These rules can be learned either through instruction or through experience with instances that either are members of the class (positive instances) or are not (negative instances). Thus, one learns to classify a set of animals as birds or nor birds on the basis of instruction or experience that leads to acquiring rules for combining characteristic attributes of birds (e.g., wings, bills, feathers). Instruction, according to **Bourne**, should involve presentation of both positive and negative instances (e.g., for birds, pigeons versus bats) so that critical attributes clearly can be linked to the concept. Presumably, use of these rules unambiguously classifies a new instance as either a bird or nonbird. Note, however, that this classification is a very simple one-a new instance either is a bird or is something else, a nonbird!

Although a rule-based conceptual system works to organize information for many concepts, it is inadequate for others. **Most natural or "real-world" concepts are more "fuzzy" and differ qualitatively from those studied in the laboratory.** For instance, consider the concept furniture. Our past experience would let all of us quickly agree that furniture includes tables, chairs, sofas, and floor lamps. *Furthermore, we can describe many rules that differentiate articles of furniture from other objects. But some of our attempts at rule formation quickly run into trouble.* **Presence of legs?** But what about some floor lamps? A seating surface? But what about tables or a desk? Is rug furniture? Some would say that it is, but would wish to include a Qualifying statement or "hedge"-it is like furniture, but not exactly like it. What is the set of rules that unambiguously determine which objects are members of the concept class furniture? Logical efforts to determine such sets of rules mostly have been unsuccessful, especially with ambiguous examples such as **Rug. Rosch and Mervi**, dissatisfied both with the artificiality of laboratory work on concept formation and with the difficulties of classifying concepts with rule-governed approaches, proposed an alternative view based on-degree of family resemblance" to a highly typical instance of the concept, a prototype.

3.6 Analogy and Metaphor Comprehension

Analogy and Metaphor Comprehension

Analogy is to human reasoning as bricklaying is too human building. In conjunction with categorization, it is one of the principal means by which knowledge about the world is acquired and structured. As a result, considerable effort has been put into the understanding of analogy by a variety of disciplines. **Verbal analogies** *have been the target of a considerable amount of that attention, and such research has begun to be integrated with research on metaphor comprehension.* The requirement for integration arises because it is known that **some analogies can be metaphorical,** and because metaphors can often be regarded as analogies. One view of metaphor is that it constitutes a mapping of the elements of one set on to another; and that it is the use of a given relation in a group of things to facilitate the discrimination of an analogous relation in another group. Simple, or sentential, metaphors are assumed to be represented by simple, proportional analogies (A: B: C: D), whereas extended metaphors, or models, require more complex analogical representation. There are many accounts of the nature of the relationship between analogy and metaphor, to which the interested reader is directed.

Analogical thinking, in the general propositional view, **is a means of recording similarities** between elements that already exist in the knowledge base, and whose properties are static; **subject to a set of constraints.** There is a similarity between this and a view of metaphor in which comprehension is seen to proceed by *(a) a retrieval of sets of semantic features that are propositional in nature, and (b) a selection from these features of an appropriate 'common ground' for the metaphor.* **In terms of Miller**, the propositional view of metaphor is more akin to the construction of semantic models than it is of memory images.

From the point of view of cognitive psychology, **we come to know things by gathering, processing, and storing information.** This is accomplished through **sensation and perception, learning and memory, and thinking.** Thinking involves mentally acting upon the information that senses, perceives, learns, and stores.

Meant of mentally act on information

What do you mean when you say that we mentally act on information? Suppose you are **Dave Bowman** and, upset by the death of your fellow astronauts, you cloister yourself and a colleague inside a cubicle, away (so you assume) from the discerning ear of **Hal**. (Unfortunately, best known to you, Hal also has a discerning eye that is adroit at up-reading.) As you discuss the astronauts' deaths and other computer-related problems, **you mentally picture Hal's computer console and the countless wires, computer chips, and other electronic hardware comprising Hal.** You recall strange events and snatches of conversations you've heard in the past few days and start drawing connections between them. You trace the

problems to Hal. You discuss ways to remedy the problems and decide on one: disconnect the source of the problems.

What have you been doing? You have been thinking. You have been using information that was previously gathered and stored and have been mentally acting on it by forming ideas, reasoning, solving problems, drawing conclusions, making decisions, expressing your thoughts, and comprehending the thoughts of others. Thinking involves a variety of mental processes and operations. The ones we will examine here are mental imagery, problem solving, and creativity. But before we get to these topics, we must address the large issue of how we think. By what means do we encode incoming information so that we can think about it?

3.7 How Do We Think? Pictures and Words

How Do We Think? Pictures and Words

Think about these two very different sentences:

1. **The bulbous blue hippopotamus**, reeking from the odour of stale fishy brine, waddled into the room and plopped onto the floor with a self-satisfied grin spreading over its face.
2. **Our nation was conceived in a spirit of unity for all time**, freedom from persecution, equality for the populace, and justice unequivocable.

After reading the first sentence, could you just "see" the hippo walking through the room? Were you almost disgusted at the fish odour? Could you "feel" the vibrations when the hippo plopped to the floor? Flow about the second sentence, could you "see" unity? Freedom? Justice? How do we represent information in our minds? Do we think in pictures as the sentence about the blue hippo illustrates, the answer seems to be yes. But most of us probably didn't call to mind any mental pictures when we read about the abstract concepts of justice and equality, yet we still understood what was being said.

There is some controversy over how information is represented in our minds. Some experts believe we encode information about real objects and events into mental representations of those objects and events. **When we think, we mentally manipulate these mental images.** Others believe that we encode information in terms of verbal descriptions called propositions and that mental images are sometimes added to the propositions after they are retrieved from memory.

A proposition is defined as the smallest unit of knowledge that can be validated as true or false. Even though propositions are really abstract cognitive events, most propositional theories depict them as short sentences, such as **"Clinton is president." John Anderson** has proposed a theory called adaptive control of thought

(ACT) based on propositions. Anderson envisions propositions at the nodes of a net with all strands of the net leading to propositions. In this way, all thought processes are made up of propositions or combinations of propositions. **Allan Paivio** has combined mental images and verbal images (propositions) into a theory of cognitive processing known as the dual-coding hypothesis.

3.7.1 The Dual-Coding Hypothesis

The Dual-Coding Hypothesis

According to the dual-coding hypothesis, **information is encoded by means of both an imagery system and a verbal system,** each working independently. We use the imagery system for processing real, concrete items and pictures, such as blue hippos and a painting of the **Mona Lisa**. We use the verbal system for more abstract items, such as spoken or written words and concepts such as liberty. So the imagery system is specialized for processing information about nonverbal objects and events, whereas the verbal system is specialized for processing linguistic information and generating speech.

Chapter 4: Frontiers of Creativity

The Many Facets of Creativity

4.1 The Many Facets of Creativity

Before providing an overview of the current findings and levels of interest in creativity research, **some attention will be focused on the definitional issues surrounding creativity.**

A Multi-Faceted Phenomenon

4.1.1 A Multi-Faceted Phenomenon

It is probably most productive to **view creativity as a multi-faceted phenomenon rather than as a single unitary construct capable of precise definition. Guilford's** address provided an impetus to many to undertake creativity research. The address also provided renewed encouragement, to those who were already involved in such research. As the creativity literature began to expand so did the number of definitions used for the concept. Only nine years following Guilford's address, Taylor found an excess of one hundred definitions of creativity in the literature. These definitions are varied and some could be considered conflicting. Welsch reviewed twenty-two definitions of creativity to find elements of agreement and disagreement. She was searching for a definition that would be applicable to a variety of creative activities and stated:

> **The definitions of creativity are numerous, with variations not only in concept,** but in the meaning of sub concepts and of terminology referring to similar ideas. There appears to be, however, a significant level of agreement of key attributes among those persons most closely associated with work in this field. Significantly for this study, the greater disagreements occur in relation to aspects that are less relevant to educational purposes. On the basis of the survey of the literature, the following definition is proposed.. Creativity is the process of generating unique products by transformation of existing products. These products, tangible and intangible, must be unique only to the creator, and must meet the criteria of purpose and value established by the creator.

Of course, not everyone associated with creativity research would agree with this definition.

One of the major reasons for the complexity of the field of creativity research is the diversity of theoretical perspectives upon which the research is based. Many of these theoretical approaches are intertwined which adds to the semantic confusion. For example, the concepts of problem solving and creative learning are frequently

linked together. Guilford defined problem solving as facing a situation with which you are not fully prepared to deal. Problem solving occurs when there is a need to go beyond the information given, thus there is a need for new intellectual activity. Guilford reported that:

> … **Problem solving and creative thinking are closely related. The very definitions of those two activities show logical connections. Creative thinking produces novel outcomes, and problem solving involves producing a new response to a new situation, which is a novel outcome.**

This definition is also very closely related to a framework for **describing the process of creative learning put forth by Torrance and Myers.** They described the creative learning process as:

> ... becoming sensitive to or aware of problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; bringing together available information; defining the difficulty or identifying the missing element; searching for solutions, making hypotheses, and modifying and retesting them; perfecting them; and finally communicating the results.

The fact that there is no widely-held and uniformly applied definition of creativity has added fuel to the argument that creativity is a difficult field to study.

The 4P's of Creativity

4.2 The 4P's of Creativity

About ten years after **Guilford's address**, **Rhodes** responded to the criticism levelled at those attempting to study creativity due to the loose and varied meanings assigned to the word "creativity." **Rhodes** set out to find a single definition of the word by collecting **an excess of fifty-six different definitions.** Despite the profusion of those definitions, he reported:

> … "As I inspected my collection, I observed that the definitions are not mutually exclusive. They overlap and intertwine. When analyzed, as through a prism, the content of the definitions form four strands. Each strand has unique identity academically, but only in unity do the four strands operate functionally."

The four strands Rhodes discussed included information about the: person (personality, intellect, traits, attitudes, values and behaviour); **process** (stages of thinking people go through when overcoming an obstacle or achieving a goal); **product** (characteristics of artefacts or outcomes of new thoughts, inventions, designs, or systems); **and press** (the relationship between people and the environment, the situation and how it affects creativity). Each of these four strands operates as identifiers of some key components of the larger, more complex, concept of creativity.

This classification scheme has been used quite extensively in the creativity literature and helps to provide some frame of reference in studying creativity. **This general approach to the definition of creativity appears to be more fruitful than attempting to specify a single definition which would be appropriate for all contexts.** Keeping the definition rather general does feed the notion that creativity is a complex concept.

The Creative Personality

4.2.1 The Creative Personality

The questions within the area of the creative personality include the identification of traits or characteristics to differentiate creative persons from their less creative peers. The major response to this type of question has been research through biographical descriptive and empirical methodologies utilizing readily identified **"creators"** and attempting to distil their attributes. The end products of these investigations are lists and tests of characteristics and traits that have something to do with being creative. These lists do not provide a comprehensive picture of the creative personality. As **MacKinnon** has emphasized … *"There are many paths along which persons travel toward the full development and expression of their creative potential, and there is no single mould into which all who are creative will fit. The full and complete picturing of the creative person will require many images."*

Many psychological theorists have provided a diversity of characteristics of the creative person. **Torrance** *introduced a multi-faceted model for thinking about the search for creative behaviour.* This model takes into consideration, in addition to **creative abilities, creative skills and creative motivations.** He stated that "High level(s) of creative achievement can be expected consistently only from those who have creative motivations (commitment) and the skills necessary to accompany the creative abilities." Other multi-faceted models for dealing with the creative personality have been put forth by **Amabile, Gowan, and Rerizulli**.

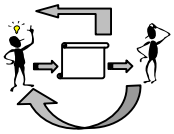
Within the scope of research into the creative personality, the questions concerning why people choose to create are central. **Amabile** also refers to a three-faceted model for examining creativity. Hers includes domain-relevant skills, creativity-relevant skills and task motivation. She focuses her attention on the former and promotes the hypothesis that intrinsic motivation is important for creativity.

Another aspect to the study of the creative person **relates to knowing more about the personal orientation toward problem solving and creative thinking. Isaksen and Treffinger** suggest that it is helpful for individuals to have information regarding their learning and thinking style when learning how to use creative problem solving. Some of the current research within this area focuses on studying different styles of creativity and how these styles may affect different

elements of creativity. Certain personality characteristics will influence preferences regarding what type of information people pay attention to, how they collect and analyze that data, and how they choose to use the information. Most previous literature on the creative personality focused upon the difference in level of tendency or achievement. It is the area of style of creativity which provides an entirely new lens to utilize regarding the study of the creative person. The new focus is upon how people differ in their approach to using their creativity, not upon their level of qualitative factors. Selection Twelve provides an overview to this emerging line of style of creativity through the work of Kirton.

The Creative Process

4.2.2 The Creative Process



One of the earliest descriptions of the creative process was provided by Wallas. ***He described four stages for this process including:*** preparation, incubation, illumination and verification. Research regarding the creative process relied upon retrospective reports, observation of performance on a time-limited creative task, factor analysis of the components of creative thinking, experimental manipulation and study of variables presumably relevant to creative thinking and simulation of "creative" processes on computers.

Some of the questions relating to the creative process include: What are the stages of the creative thinking process? Are the processes identical for problem solving and for creative thinking? What are the best ways to teach the creative process? How can the creative process be encouraged? Is the creative process similar in different contexts?

The usually mentioned description of creative learning is sometimes equated with what is meant by the creative process. In both, there is a description of various stages of thinking and problem solving when an individual is confronted with a challenge or opportunity. These stages provide the basis for the **creative problem solving (CPS)** process. Current thinking about the CPS process describes the process as having two mutually - important types of thinking. **Osborn** originally referred to these as imaginative and evaluative. Current language for these types of thinking is creative and critical, respectively. Creative thinking involves making and communicating meaningful new connections to: think of many possibilities; think and experience in various ways and use different points of view; think of new and unusual possibilities; and guide in generating and selecting alternatives. Critical thinking involves analyzing and developing possibilities to: compare and contrast many ideas; improve and refine promising alternatives; screen, select, and support ideas; make effective decisions and judgments; and provide a sound foundation for effective action. These two types of thinking are seen as mutually important components of effective problem solving. Although much of the historical emphasis within programs which

teach CPS has been on the development of divergent thinking, there is an increasing emphasis on providing a balanced approach including the development of both divergent and convergent thinking skills. This more balanced approach is consistent with recent research in the problem solving and intelligence fields.

Much of the emphasis regarding the creative process involves the teaching or training of explicit methods and techniques in order to help solve problems and think more effectively.

Despite the difficulties inherent in the problem-solving literature (research based on highly artificial problems, a wide variety of tasks and studies, and others), several lines of inquiry appeared fruitful:

> ***First,*** there is some evidence that various heuristics are used by effective problem solvers in many areas of activity when confronted by new types of problems and that these heuristics can be identified. ***Second,*** there are converging lines of evidence that a major role is or can be played by a managerial function that selects strategies and plans attacks on problems. ***Finally,*** the study of how problem solvers within specific fields learn to solve the field-specific problems they face suggests several generic skills that cut across fields.

These findings are qualified by pointing out that the actual field or context within which the problem solving occurs provides the requisite knowledge as well as the procedures and outlets necessary to implement the generic skills.

The connections which exist between the creative process and teaching for thinking are well-documented in a vast collection of literature. There are many historical antecedents for this type of teaching. One of the earliest spokespersons of the importance of the deliberate development of thinking was **Dewey**. He charged teachers with the responsibility to know the process of reflective thought and facilitate its development, indirectly, in students by providing appropriate conditions to stimulate and guide thinking.
Dewey's work continues to be a focal point for those concerned with the development of thinking skills.

Another emerging line of inquiry within the broad area of the creative process is the concept of mental imagery and its place in creative problem solving. There is a growing amount of information regarding the concept of imagery and visualization.

4.2.3 The Creative Product

The Creative Product

The centrality and importance of studying the creative product has been pointed out by Mackinnon.

Although many researchers acknowledge the importance of this line of investigation, there appears to be a paucity of empirical investigation on the topic of creative products. One of the possible explanations for the lack of research in this area is the opinion that the problem is too easy. In other words, the identification of creative products is "obvious." Everyone knows a creative product when they see one. **MacKinnon** pointed out that this view might account for the scarcity of scientific investigation of creative products.

There are some who have conducted investigations of creative products. Much of this work has dealt with creative products in specific contexts. Very little has been done beyond individual disciplines and contexts to gain a more general picture of the characteristics of creative products. Although much emphasis has been placed on the need for a creative product to be novel; it is interesting to note that the current trend is to include aspects of relevance and appropriateness to the description of the creative product.

A related and more thoroughly-researched area of study dealing with creative products involve the diffusion of innovations. There appears to be a general increase of interest in how new ideas or products are communicated or accepted by others. An increased interest in the process of innovation has also increased concern for studying communication to promote acceptance of new ideas. This area of study is called the diffusion of innovations.

When the book **"Diffusion of Innovations"** was first published in 1962, there were 405 publications about this topic available in the literature. By the end of 1983, there were more than 3,000 publications about diffusion, many of which were scientific investigations of the diffusion process. **Rogers** described diffusion as an information exchange occurring as a convergence process involving interpersonal networks. He asserted that the diffusion of innovations is a social process for communicating information about new ideas. The study of this process has examined specific attributes of innovations (such as relative advantage, compatibility, complexity, trial ability, and observability) and how they influence acceptance.

These attributes of innovations may account for many of the reasons for their acceptance, but there are other variables which must also have an effect on the diffusion of new ideas and inventions. Other variables would include: the number of people involved in making a decision; the type of communication used; the environment or culture; and who is supporting or selling the new idea or product.

The Creative Press

4.2.4 The Creative Press

The term "press" refers to the relationships between individuals and their environments. This facet of creativity includes the study of

social climates conducive or inhibitive to the manifestation of creativity, differences in perception and sensory inputs from varying environments, and the various reactions to certain types of situations. The questions guiding study within this area include understanding the environmental conditions that have an effect on creative behaviour, how these conditions effect creativity and how they can be used to facilitate creativity. The research approaches have included case study, interview and survey techniques with small groups and organizations.

Torrance synthesized the findings of various investigators and listed the following as necessary conditions for the healthy functioning of the preconscious mental processes which produce creativity:

1. The absence of serious threat to the self willingness to risk;
2. Self-awareness ... in touch with one's own feelings;
3. Self-differentiation ... sees self as being different from others;
4. Both openness to the ideas of others and confidence in one's perceptions of reality or ideas; and
5. Mutuality in interpersonal relations ... balances between excessive quest for social relations and pathological reflection of them.

Investigation into creative environments has included attention to the educational and organizational areas. There has been much recent attention to the climate conducive to creativity and innovation from the business and industrial community. The emphasis of this research has been to identify those factors, in certain organizations, that account for creative behaviour. The findings from business and education are somewhat similar in that the climates in both types of organizations appear to be supportive of the intrinsic motivation hypothesis put forth by Amabile.

The popular literature contains many lists of suggestions for creating an environment conducive to creativity. **Van Gundy** identified three categories of factors that determine a group's creative climate. They are: **the external environment, the internal climate of the individuals within the group, and the quality of the interpersonal relationships among group members**. He acknowledged that there would be considerable overlap among these categories and that each category would include suggestions that deal with both task and people-oriented issues.

A common thread running through all these suggestions is the encouragement of group involvement and increasing the level of ownership over activity and decisions. Although there are plenty of times a leader would not care to use group resources when making a decision, the climate literature suggests the decision to use or not to use a group should be based on more than personal preference. Situational variables such as: the needed quality of decision; the

amount of information available; the needed level of commitment to the decision; the amount of conflict in existence; and many other factors could have an impact on deciding when and where to use group resources. When examining the many suggestions to establish a creative climate it is important to keep the concept of balance in mind. Taking as many factors into consideration when using those suggestions will help to moderate the many variables affecting their appropriate application.

A related factor to consider when attempting providing a creative climate is the type of leadership role required for the situation at hand. There aree different kinds of leadership appropriate for different kinds of situations. In considering the kind of environment within which creativity flourishes, it becomes apparent that a different type of leadership role is necessary. Some use the term “facilitator” to describe this leadership style. Others use the term “mentor”.

Another common theme within the climate literature is that the kind of environment which is supportive of creativity and innovation will allow individuals to be aware of their own blocks to creative thinking. The focus is on providing a climate where these can be minimized. Some of these blocks can be personal (such as the inability to take risks), problem solving (such as working only within a fixed "set"), or situational (like a great deal of emphasis on negative criticism). Taking time within a group or organization to develop an orientation to these inhibitors may provide reinforcement of the ground rules for the creative environment and may reduce the likelihood of the manifestation of blocks.

4.2.5 Stages of Creativity

Stages of Creativity

The first well-known attempt to conceptualize the creative process was by Wallas in 1926. Although Wallas did not identify specific processes, he did articulate different stages that reflect different processes. Although Wallas's stages are crude and global, his four-stage model has helped order our thinking about the creative process. His four-stage model consists of:

Preparation Stage-information gathering

Incubation

1. ***Preparation Stage*-information gathering**, mastering the knowledge base, identifying the problem. It is in this stage that the basic techniques and knowledge base of a particular domain are mastered. For example, techniques of painting are mastered or the research literature is totally investigated. It is probably in this stage that basic intellectual processes are important in determining the rapidity of learning and the complexity of issues that are tackled.
2. ***Incubation*** *Stage*-ideas incubate without the individual directly, logically working on the problem. It is in this stage that processes unique to the creative process are so important. It is also in this stage that Wallas and others introduced the concept of the unconscious. Problems are not consciously worked on, but much

restructuring and free associating occurs outside of conscious awareness. There are several descriptions by creative individuals of the subjective experience of the incubation stage. Thoughts are permitted to roam in a free-ranging manner. It is here that affective processes may play an especially important role.

Illumination

3. ***Illumination*** *Stage*-the solution to the problem occurs or is recognized. The artistic plan develops. This stage is often referred to as the "aha" experience of the creative scientist. In reality, as many have pointed out, reaching a solution is probably a gradual process in most instances. The sudden illumination occurrence is probably the least frequent manner by which a solution occurs.

Verification

4. ***Verification*** *Stage*-the solution must now be evaluated. Is it indeed good? The hypothesis must be tested; the painter must stand back and evaluate and rework the painting. Critical thinking and logical thinking must be dominant in this stage.

In general, the basic cognitive processes of logic, memory, and abstract thinking should be dominant in the first and last stages. Different types of cognitive processes should be dominant in Stages 2 and 3. Stages 2 and 3 are especially important in creative problem solving and creative artistic expression. It is in the incubation stage that affective processes most likely play a major role.

As Gruber correctly pointed out, Wallas's stage model is incomplete. It does not include the early stage of problem finding or the final stage of expansive application of the creative product. However, Wallas' basic stages remain theoretically useful and continue to be the basis for training approaches.

As Vinacke stressed, the stages of this creative process are probably not so ordered as Wallas first proposed. Individuals go back and forth rapidly between the stages, sometimes letting their thoughts roam, sometimes calling on their critical thinking faculties. It is the ability to shift between stages that are important to the creative process, perhaps involving the ability to gain access to or call into play creative cognitive and affective processes (or let them occur). Psychoanalytic theorists refer to this ability as “regression in the service of the ego".

4.2.6 Cognitive Creative Processes

Cognitive Creative Processes

A key theoretical question in the area of creativity is **"what cognitive and effective processes are involved in the creative process?"** Much of the focus in the area of creativity research has been on cognitive processes.

Guilford *made major theoretical contributions to the area of creativity in that he identified and investigated cognitive processes not previously focused on in tests of intelligence.* **In general, Guilford** believed that creativity was made up of many different components.

He discussed both cognitive processes and personality traits as contributing to creativity. His research, however, focused on cognitive processes. **Guilford's work** was based on several principles that continue to be the basis for creativity research today.

The first principle was that creative abilities fall on a continuum. **Guilford** did not hold to the view that only a selected number of eminent individuals were creative and should be studied. All individuals possess creative abilities to some degree, "creative acts can therefore be expected, no matter how frequent or how infrequent, of almost all individuals". Thus, creativity can be studied in normal populations.

A second principle was that creative thinking is something different from what intelligence tests measure. Intelligence tests measure logical thought processes that reflect convergent thinking. ***There is one best answer for a problem,*** not a variety of responses as in creative divergent thinking. Research has supported the concept that creative abilities are separate abilities from what we define as intelligence. Most studies find low to moderate positive correlations between creativity tests and intelligence tests. Until recently, it was widely accepted that a certain amount of intellectual ability was necessary for creativity to occur. Studies show that in the upper ranges of intelligence, the correlation with creativity is zero. This has been known as the threshold theory. However, work by Runco suggested that the relationship between creativity and intelligence is a function of the measures used and the samples studied. He concluded that the threshold theory is "at least partly a psychometric artefacts".

Guilford's third principle is that creativity is really a form of problem solving-not a magical, mysterious process. Guilford also stated that Wallas' four-stage model of creativity is consistent with other models of problem solving.

Guilford identified cognitive processes that were unique to creativity. He concluded that two major categories of cognitive processes were important in the creative process. First, "divergent production abilities" were uniquely important in the creative process. **Guilford** thought that the key concept underlying divergent production abilities is variety. One can generate a variety of solutions to a problem or associations to a word. Divergent thinking is thinking that goes off in different directions. For example, a typical item on a divergent thinking test would be "how many uses for a brick can you think of?" As **Guilford** stated "divergent thinking is a matter of scanning one's stored information to find answers to satisfy a special search model". A broad base of search and free-ranging scanning ability increases divergent thinking production. Wallash stated that divergent thinking is dependent on the flow of ideas and the "fluidity in generating cognitive units". He stressed the importance of the ability

to "ride the associative currents". Divergent thinking should be especially important in the incubation stage of Wallas' stages of creativity.

The second category of abilities relevant to creative ability is what Guilford termed ***"transformation abilities"***. These abilities enable the individual to transform or revise what one knows into new patterns or configurations. A flexibility to reorganize and break out of old sets is important here. The individual reorders, redefines, or reinterprets what is currently known. One sees a new solution to a problem that is different from the usual approach. Much of Guilford's research focuses on identifying cognitive processes that make up these two categories of abilities divergent thinking and transformation abilities and devising tests of these abilities.

Guilford conceptualized these abilities as cognitive abilities. Although he felt that personality characteristics were important to creativity, he believed that they were separate from these cognitive processes. However, recent research suggests that effective processes influence divergent thinking abilities and transformation abilities.

Currently, major work on the cognitive processes involved in creativity has been carried out by a number of researchers stressed the importance of insight in creative thought. **Sternberg and Davidson postulated that three types of insights are involved in creativity. Selective encoding** involves separating relevant from irrelevant information. **Selective combination** entails synthesizing isolated pieces of information into unified wholes. Information is organized in new ways. **Selective comparison** involves relating new information to old information. These three types of knowledge acquisition **set the stage for creative insights.** One might speculate that divergent thinking abilities and transformation abilities partially underlie these types of knowledge acquisition and insight abilities.

Weisberg viewed creativity as another form of problem solving that involves matching what one knows with the situation. **He stressed the incremental nature of problem solving.** There are few real leaps of insight. Rather, novel products evolve in small steps that utilize local memory searches. **The incremental nature of problem solving is true in both science and art.** Weisberg would agree with Guilford that creative thinking does not involve extraordinary abilities, but rather ordinary cognitive processes that are found in all individuals.

On the other hand, **Metcalfe** presented evidence that some insight problems are different from memory retrieval tasks. She used a **"feeling of knowing"** paradigm to determine whether similar processes were involved in an insight problem and a memory-based trivial problem. In two studies, she found that people could predict

memory performance fairly well, but could not predict performance for insight problems. She concluded that insight problems do involve a sudden illumination that can not be predicted in advance.

Simon greatly influenced the field with his work on models of information processing and problem solving as they apply to creativity. *He also led the way in the area of computer simulation of creative problem solving. His work on selective forgetting and familiarization* ***in memory helps explain the insight process.*** **Langley and Jones** developed a computational model of scientific insight. They stressed the importance of use of analogy in creative problem solving. Insight involves the recognition, evaluation, and elaboration of analogies. Memory processes are important in recognizing appropriate analogies for new situations.

Personality Traits

4.3 Personality Traits

A climate that is conducive to evoking creative behaviour can be established in a number of ways, and they are based upon principles of creative behaviour that research has confirmed. *Climate, or atmosphere, takes into consideration three major factors: the physical, the mental, and the emotional.* Knowing what we do about individual styles of learning and the variety of ways a teacher employs motivational strategies to reach different kinds of students, it is desirable to account for all three of the major factors.

In giving attention to physical, mental, and emotional aspects of climate, we set a stage for both intended and unintended learning (and motivation toward learning) to occur, in other aspects that should and will revolutionize educational practices. J.P. Guilford's recent book, Way Beyond the I.Q., is a marvellous contribution to our knowledge of human intelligence.

Personality Traits of the Creative Individuals

4.4 Personality Traits of the Creative Individuals

Numerous studies have been conducted on personality traits that tend to help or hinder creative output. Among those traits most commonly identified as helpful toward one's creative productivity are:

Openness to experience
Independence
Self-confidence
Willingness to risk
Sense of humour or playfulness
Enjoyment of experimentation
Sensitivity
Lack of a feeling of being threatened

Personal courage
Unconventionality
Flexibility
Preference for complexity
Goal orientation
Internal control
Originality
Self-reliance
Persistence
Curiosity
Vision
Acceptance of disorder
Tolerance for ambiguity
Motivation
Inclination to the off-beat

Personality traits that have been identified as characterizing creative individuals are often thought of in the light of Thoreau's person who hears a different drummer. The person is generally a nonconformist but not necessarily in an abrasive way. In fact, timidity is often a trait attributed to a creative person. A number of the characteristics seem to be juxtaposed to others. **Are these traits innate, or are they acquired?** If they can be acquired, the question for educators, then, is how can these traits be developed?
That question leads directly to the influence of one's environment on his or her ability to perform creatively. **Most often we think of the environment that will nurture creative behavior as one that is supportive of the individual. Support here is not false praise,** but rather honest support that dignifies the individual. Environmental support allows mistakes and encourages experimentation, openness, and risk taking. It provides a climate for one to explore his or her potential.

Is it always the warm nest, though, that evokes creative behavior? In initial exposure, perhaps it is. But extreme human suffering, which necessitates the need for expression into a creative product, is often grist for the mill for later on. Some of the world's greatest literature evolved in times of human crisis. And the saying "Necessity is the mother of invention" is not goes through in creating is the same for all people, while others think there are as many creative processes as there are individuals. With respect to personality traits, some insist creative people are born, not made; others feel strongly that creative thinking can be taught. Advocates of environmental factors that nurture creative behavior are strong in their beliefs; their adversaries feel the creative person will perform regardless of the environment he or she is placed in.

Personality Results

4.5 Personality Results

A review of the literature by **Stein** yielded the following fist of personality characteristics that have been found associated with the creative individual.

The creative individual:

1. **Is an achieving person**. He scores higher on a Self-Description Test of need achievement than in a projective (TAT) [Thematic Apperception Test] measure of the same variable, possibly because his achievement is fulfilled in actuality and need not be converted into fantasy.
2. **Is motivated by a need for order**.
3. **Has a need for curiosity.**
4. **Is self-assertive, dominant, aggressive, and self-sufficient.** He leads and possesses initiative.
5. **Rejects repression, is less inhibited, less formal, and less conventional,** is bohemianly unconcerned, is radical, and is low on measures of authoritarian values. However, MacKinnon finds that the creative individual is not "bohemian."
6. **Has persistence of motive**, liking and capacity for work, self-discipline, perseverance, high energy-output, is thorough.
7. **Is independent and autonomous**.
8. **Is constructively critical**, less contented, dissatisfied.
9. **Is widely informed**, has wide ranging interests, is versatile.
10. **Is open to feelings and emotions**. For him feeling is more important than thinking, he is more subjective, he possesses vitality and enthusiasm.
11. **Is aesthetic in his judgment and value orientation**.
12. **Is low in economic values** or is a poor business man, however, found with the all port-Vernon-Lindzey Scale of Values that their more creative industrial research chemists did have higher economic values than their less creative colleagues.
13. **Possesses freer expression** of what has been described as feminine interests and lack of masculine aggressiveness.
14. **Has little interest in interpersonal relationships**, does not want much social interaction, is introverted, is lower in social values, and is reserved.
15. **Is emotionally unstable** but capable of using his instability effectively, not well adjusted by psychological definition but adjusted in the broader sense of being socially useful and happy in his work.
16. **Sees himself as creative**. He is also more likely to describe himself in terms that investigators have found to be related to creativity than is true of less creative individuals. For example, MicKinnon in his study of architects found that his **more creative** group described themselves more frequently as **inventive, determined,**

independent, individualistic, enthusiastic, and industrious," while his **less creative** group described themselves more frequently as **"responsible, sincere, reliable, dependable, clear thinking, tolerant, and understanding**". In short, where creative architects more often stress their inventiveness, independence, and individuality, their enthusiasm, determination, and industry, less creative members of the profession are impressed by their virtue and good character and by their rationality and sympathetic concern for others. Considered in terms of their ideals, MacKinnon also found that the more creative group would like to be more sensitive, while the less creative groups would like to be more original and, at the same time, more self-controlled and disciplined.

17. **Is intuitive and empathic.**
18. **Is less critical of himself**. He is less inclined to use negative and unfavorable adjectives.
19. **Makes a greater impact on others.**

These findings do not characterize any single individual. *No creative individual has all these characteristics, but a creative person probably has more of them than does a less creative person.* Evidence for personality factors characteristic of creative persons comes from studies of individuals in a wide variety of different scientific and professional fields: biology, psychology, chemistry, engineering, architecture. Just as these individuals differed from each other in field of endeavor, they also differed from each other in age, educational status, administrative status, etc. And in the studies in which they participated, there were also differences in the psychological tests and techniques used to gather data as to their creativity.

Guilford's Intellective Factors

4.6 Guilford's Intellective Factors

One of the more important developments in the field of creativity has been Guilford's works on intellective factors. Work began out of both theoretical and statistical considerations that led him to be critical of traditional intelligence testing procedures. It would take us too far a field to consider all the issues involved; hence we shall limit ourselves to what he has to say directly about the relationships between intelligence testing and creativity.

In 1950 Guilford said, "we must look well beyond the boundaries of the I.Q if we are to fathom the domain of creativity" and he voiced the belief that the idea "that creative talent is to be accounted for in terms of high intelligence or I.Q ... is not only inadequate but has been largely responsible for lack of progress in the understanding of creative people."

To arrive at a conceptualization of the different possible factors involved in the structure of the intellect, **Guilford used a technique called morphological analysis.** This is a technique for stimulating creativity and therefore as an aside Guilford's work is a good illustration of this technique's use and value.

Guilford's morphological model consists of three dimensions or parameters operations, contents, and products. Each of these dimensions consists of several categories. Operations, which as its name indicates, is the operation performed on material, consists of the following categories: cognition, memory, divergent production, convergent production, and evaluation. Contents, or the medium in which the thought occurs, consists of four categories: figural, symbolic, semantic, and behavioral. And Products consists of the results of the combinations of both operations and products and includes six categories: units, classes, relations, systems, transformations, and implications. All of these are more fully defined in Table 4.1.

Table 4.1: Definitions of categories in GuilFord's structure of intellect

Operations

Operations
Major kinds of intellectual activities or processes; things that the organism does with the raw materials of information, information being defined as "that which the organism discriminates."
Cognition. Immediate discovery, awareness, rediscovery, or recognition of information in various forms; comprehension or understanding.
Memory. Retention or storage, with some degree of availability, of information in the same form in which it was committed to storage and in response to the same cues in connection with which it was learned.
Divergent Production. Generation of information from the given information, where the emphasis is upon variety and quantity of output from the same source. Likely to involve what has been called transfer. This operation is most clearly involved in aptitudes of creative potential.
Convergent Production. Generation of information from the given information, where the emphasis is upon achieving unique or conventionally accepted best outcomes. It is likely the given (cue) information fully determines the response.
Evaluation. Reaching decisions or making judgments

concerning criterion satisfaction (correctness, suitability, adequacy, desirability, etc.) of information

Contents

Contents

Broad classes or types of information discriminable by the organism.

Figural. Information in concrete form, as perceived or as recalled possibly in the form of images. The term "figural" minimally implies figure-ground perceptual organization. Visual spatial information is figural. Different sense modalities may be involved, e.g., visual kinesthetic.

Symbolic. Information in the form of denotative signs, having no significance in and of themselves, such as letters, numbers, values musical notations, codes, and words, when meanings and form are not considered.

Semantic. Information in the form of meanings to which words commonly become attached, hence most notable in verbal thinking and in verbal communication but not identical with words. Meaningful pictures also often convey semantic information.

Behavioural. Information, essentially nonverbal, involved in human interactions where the attitudes, needs, desires, moods, intentions, perceptions, thoughts, etc., of other people and of ourselves is involved.

Products

Products

Forms that information takes in the organism's processing of it.

Units. Relatively segregated or circumscribed items of information having "thing" character. May be close to Gestalt psychology's "figure on a ground."

Classes. Conceptions underlying sets of items of information grouped by virtue of their common properties.

Relations. Connections between items of information based upon variables or points of contact that apply to them. Relational connections are more meaningful and definable than implications.

Systems. Organized or structured aggregates of items of information; complexes of interrelated or interacting parts.

Transformations. Changes of various kinds (redefinition, shifts, or modification) of existing information or in its function.

Implications. Extrapolations of information, in the form of expectancies, predictions, known or suspected antecedents, concomitants, or consequences. The connection between the given information and that extrapolated is more general and less definable than a relational connection.

Guilford regards the combination of any three categories from the three dimensions as consisting of a psychological factor. ***For example,*** cognition of figural systems is called spatial orientation; cognition of semantic implication is conceptual foresight; divergent production of symbolic units is called word fluency; and divergent production of semantic units is called ideational fluency, etc. For each of these factors tests have been developed.

Relating his own studies of intellect to creativity, **Guilford says,**

> *"Although the most obvious aspects of creative thinking appear to depend on the abilities to do divergent-productive thinking and the abilities to effect transformations of information, with the abilities of fluency, flexibility, elaboration, and redefinition playing significant roles, with creative thinking put in its larger context of problem solving, we see that any or all kinds of abilities represented in the structure of intellect can play their useful roles, directly or indirectly."*

To illustrate Guilford's factors and the tests used to get at them, let us consider the divergent production factors. A factor that Guilford calls word fluency (divergent symbolic units) consists of thinking up and writing out words containing a specified letter, e.g., the letter "g"; two of the tests for ideational fluency (divergent semantic units) are Plot Titles (nonclever) in which the subject is asked to list "possible titles for a given short story" and the score is the number of nonclever titles produced. And another is the Utility Test in which the subject is asked to list "uses he can think of for a common brick, or a wire coat hanger." The score is based on "the total number of relevant responses." When the uses for the common brick and lead pencil given by a person are scored for the number of shifts in classes in consecutive responses, it becomes a measure of semantic spontaneous flexibility.

Guilford's tests, especially those designed to measure divergent-production factors, have been used, as indicated previously, in various ways by researchers investigating creativity. Some have used the tests to study differences between creative persons, selected in terms of some criterion and others who are less creative or who have not manifested any creativity. Other investigators have used **Guilford's tests** to differentiate between two groups of persons. One group scores significantly higher on these tests than does the other, and so the investigator has a psychometric criterion to differentiate between his groups. He then proceeds to

study the groups with other psychological tests. Still another third group has used the tests to measure the effects of programs designed to stimulate creativity. And a fourth group has adapted or altered some of Guilford's original tests for specific purposes. These tests are referred to later as "Guilford-like" tests. Many of Guilford's tests and the Guilford-like tests are regarded as tests of creativity by some investigators, not because they have the evidence that the tests correlate with independent measures of manifest creativity, but because the tests appear to measure psychological functions that are assumed to be involved in the mental operations of creative persons during the creative process.

Chapter 5: Barriers to Creativity

Commonly Identified Barriers

5.1 Commonly Identified Barriers

What is it that keeps children, teen-agers, or adults from exercising their creative potential? What is it about ourselves, about the way we think and feel, the way we live, the way we relate with other people and to the things that surround us?

***Fundamentally,* each individual must figure out what barriers to creative expression exist within him or herself.** We all need to discover whether those barriers are internal or external and which are real or imagined. Many barriers are self imposed. If we assume that we are incapable of some task for some reason or another, we will most likely not attempt it. Many children in schools, for example, who are convinced they will fail, for any of a myriad of reasons, will not try.

And, just as we make negative assumptions about ourselves, we make negative assumptions about others. This becomes a dangerous indictment if one is in a position of influence over others, particularly a teacher. In schools we have a tendency to classify students on a continuum from most capable to least capable. The expectations we have of others are usually the ones they'll live up to.

Barriers to utilizing creative potential can be categorized into historical, biological, physiological, sociological, and psychological barriers.

Historical Barriers

5.1.1 Historical Barriers

In the historical sense, the following examples might give reason for an individual or a society not to attempt the new, to seek another solution, to find a better way**. From the ancient Greeks**, for example, there was **Plato** maintaining that history repeats itself. He wrote so convincingly of the circles of civilizations repeating themselves that to many it has seemed futile to attempt any changes. Plato's concept would have us be totally fatalistic and powerless as individuals and as societies.

These are but a few examples of historical significance to illustrate external dominance over human thought. It is technological advances, in the recent past and in the present that leave average people feeling that they have little, if any, control over their own lives.

Biological Barriers

5.1.2 Biological Barriers

From a biological point of view, **some scholars insist that creative ability is a hereditary trait,** while others maintain that environment is the major factor. Inherited genes do play a role within the measures of any kinds of intelligence; but too often, in the case of creative intelligence, heredity seems to be more excuse than actual fact.

Physiological Barriers

5.1.3 Physiological Barriers

Physiological barriers **can exist through types of brain damage one might incur through disease, or accident**. Or one might have a physical disability of some sort that prevents certain types of productivity. Yet, **John Milton** was blind and **Beethoven** was deaf...

Sociological Barriers

5.1.4 Sociological Barriers

Most certainly **our social environment affects our creative expression.** A society is comprised of individuals organized in some manner for the protection and, supposedly, the advancement of its individual members. Problems arise when the organization takes on a life of its own and is responsible for dehumanizing its members, making them feel individually insignificant. **A society shares a set of morals and traditions and is characterized by collective activities, interests, and behaviours.** Often an individual member feels that it is immoral to deviate from the norm, to appear to differ with the written and unwritten laws of his or her particular group. Whether the society is a nation or a street gang, deviations of behaviour from the group's established patterns can evoke punishments or exclusion. Therefore, unique behaviour, suggested change, and the like, are considered subversive and threaten the stability and security that others derive from group affiliation.

History has demonstrated that when the individual loses a sense of power over his or her own life, a society is ripe for a leader with a dominant personality who advocates group norms and the need to protect those norms. Such appeals to "groupness" and the group's right to sustain itself have been obvious, for example, in Nazi Germany, Communist China, and several African nations.

Also, within a particular sociological setting, whether it is a family, a school, a bridge club, a ball team, there are class systems, designed to keep people in their place, on such bases as age, sex, appearance, ability, background, seniority, right-handedness, and so on.

Social environment is a major factor in our ability to use our creative potential and to express our own uniqueness. Creative expression involves personal risk. Negative reactions to our expressions from our own group can cause us to experience even

less self-significance. Often an individual will retreat in order to feel accepted. The implications here are strong for those who attempt to evoke creative behaviour through teaching.

Psychological Barriers

5.1.5 Psychological Barriers

Given the foregoing categories of barriers to creative productivity - historical, biological, physiological, and sociological - **by far the most signifcant and prevalent barriers are psychological.** Therefore, they are the ones that demand the most attention from teachers of creative behavior. If we define a barrier as a factor that impedes progress or restricts free movement and give that definition a psychological application, then we are talking about the heart of the teaching profession: What are those elements that impede growth and development and how can they be eliminated or, at least, reduced?

The categories of barriers that have been discussed thus far are, by and large, external factors. *They are imposed, for the most part, by forces outside us.* Many of them serve well for those who would find reason for not being productive. Some people, in fact, convince themselves that external forces will never allow them to exercise creativity. This in itself is a psychological barrier.

There are a number of psychological barriers which get in the way of the analytical and creative managers. The more important are:

Self-imposed barriers;
Patterns, or one unique answer;
Conformity;
Not challenging the obvious;
Evaluating too quickly;
Fear of looking a fool.

These are discussed below.

A) self-Imposed Barriers

A) Self-Imposed Barriers

The self-imposed barrier is one of the more difficult barriers to recognise. We put it up ourselves, either consciously or unconsciously.

b) Conformity or Giving The Answer Expected

B) Conformity or Giving the Answer Expected

The barrier of conformity follows the previous barrier in the sense that many managers feel they have to conform to the patterns established by their colleagues in the organisation in which they work.

c) Lack of effort In Challenging the Obvious

C) Lack of Effort in Challenging the Obvious

Another barrier is the lack of effort in challenging the obvious solution. **This barrier is, in fact, two barriers rolled into one**. When faced with problems, there is a tendency to go for the obvious answer, which is accepted without question. Maybe, we're just happy to have

found an answer to the problem, at all **Secondly**, having an answer we avoid challenging it, even though there may be other and better answers. There is an old problem-solving technique which suggests that whenever an answer to a problem has been found, the answer and the problem are put on one side for a day, or so. The answer is then challenged to test whether it is the right answer. More often than not, a period of conscious or unconscious thinking allows other answers to be found. These may be better, or at least may cast doubts on the original solution.

In general, managers tend to avoid following through ideas and suggestions which depart from the accepted state of affairs. The phrase, 'Why don't we ...?' is frequently answered in a negative way by working out the reasons why it cannot be done, or it would not work. For example, when we have to undertake a task which we do not very much like doing, we tend to **'put off the evil day'**, giving reasons why it would be better or more appropriate to tackle it at another time. If only we would buckle down and do it, the job would be completed in far less time than the time we spend finding excuses for not doing it!

An extreme statement of this barrier - lack of effort in challenging the obvious - is a response known as the automatic no'. **Any new idea is automatically rejected, almost without consideration.** The reason for the rejection may be that the **new idea came from a junior, a peer or even someone outside the department or section.** The rejecter has feelings of anger or jealousy at not thinking of the idea himself, and therefore rejects it out of hand.

d) Evaluating Too Quickly

D) Evaluating Too Quickly

This barrier - evaluating too quickly - **is not an easy one to remove.** Everybody has a well developed capability of evaluating ideas, and this is applied almost instinctively when ideas are put forward. As with the ‘automatic no' response, we tend to analyse and too often reject ideas which are slightly offbeat or new: **'that's silly', 'that won't work' or 'we tried it last year and it didn't work** are common phrases. The idea is then buried and a chance has been lost to develop new approaches.

One way of understanding this barrier is to look at your hands. If the left hand represents idea production and the right hand represents idea evaluation, the two hands are not separate as in real life but are linked and linked very tightly indeed. **So much so, that an idea produced is immediately evaluated and possibly killed, e.g. by the phrase, 'that won't work'.**

Success in creative thinking demands that the two linked hands should be separated, and that the right hand (idea evaluation) should be put on one side, for the moment. All ideas are acceptable in a creative situation, regardless of their quality. They may be good, bad,

useful, useless, and illegal - it doesn't matter, for in a creative session all ideas are acceptable. Subsequently, the evaluation hand is brought back and at that stage a strange thing happens. Some of the ideas, which would have originally been dismissed out of hand, are looked at afresh, possibly with the comment: 'Wait a minute, there may be something in that idea after all'. The ideas are given a chance to develop and not rejected too quickly. While the original idea may be silly or useless, it may lead onto other ideas which are readily applicable. So evaluation has no part to play in a creative situation, and all ideas, however wild or silly are accepted. Later, at the end of the session one or two really wild ideas are examined afresh.

Linked to this barrier, is the phrase, **'suspend judgment'**. In the creative situation no evaluation or judgement is allowed, either of other people's ideas or your own. Judgment is suspended until later and all ideas are accepted.

e) Fear of Looking Like a Fool

E) Fear of Looking Like a Fool

Fear of looking like a fool **is the biggest barrier of all and the most difficult to remove.** It is one of the oldest barriers in that it starts very early in life. The imagination and creativity injected into games played by very young children generate much laughter and enjoyment. Unfortunately, the laughter can be turned against an individual who then begins to say, **'they are laughing at me'**. Nobody likes being laughed at and, as a consequence, as we grow up we tend to avoid putting forward the silly or wild ideas, in case we are laughed at, or thought foolish. Another phrase applicable in creative situation is **'laugh with, not at, the wild ideas'.**

This barrier is heightened when managers from different levels in the organisation are working together to solve problems. The most junior member of the team will not put forward wild ideas in case his seniors regard him as a fool. He does not want to destroy his promotion chances and therefore, sticks with well-tried (i.e., analytical) routines. At the other end of the scale, the most senior manager seeks to protect the image he has built for himself. He says, **'I don't want to confirm junior in his opinion that I'm a silly old fool'.** As a consequence, he does not propose any wild ideas either.
This barrier has another aspect. Managers do not like going against universally accepted views, particularly when these are stated by prominent or notable people. There is a risk of being wrong, particularly if the new idea is radically different from common practice. Examples of this aspect abound in history, and are still found today. This aspect is also particularly strong when technological advance is present, and new skills are required to replace existing. **Examples of this aspect are:**

- **A cast-iron plough**, invented in 1797, was rejected by **New Jersey farmers** who said that it would stimulate the weeds and poison the plants;

- **The patent for a radio valve lapsed in 1907** as no one could find a use for it;
- **In 1906, a scientist**, **Simon Newcomb**, said that flying was quite impossible;
- **President Truman** was said to have been advised by **Admiral Leahy** that, 'Atomic bombs won't go off, and I speak as an explosives expert';
- **The railway builders in the early nineteenth century** were advised that speeds of 50 m.p.h. would cause nose bleeds, and that trains could not go through tunnels because people would be asphyxiated;
- **Brunel, building the SS 'Great Britain'**, now restored in dry dock in Bristol, was advised that, **'iron ships won't float'**. So unsure were the builders of the efficiency of boilers and propellers that they included sails as well;
- **In 1933, Lord Rutherford** said, **'The energy produced by breaking down the atom is a poor kind of a thing.** Anyone who expects a source of power from transformation of these atoms is talking moonshine';
- **In 1957, the Astronomer Royal, Sir Harold Spencer Jones**, commenting on the news of the first satellite, said that generations would pass before man landed on the moon, and that even if he did succeed, he would have precious little chance of getting back.

Statements like these made by eminent people, who really ought to know better, discourage others from trying new and unusual ideas. **Fortunately creative people are prepared to take risks** - it is they who lead the way into new technologies and procedures. They are not discouraged by criticism and, of course, are rightly acclaimed later when their ideas are found to be sound and workable.

Fear of looking foolish, or being proved wrong, *is a powerful barrier for the analytical and creative manager.* As has been suggested earlier, barriers have no place in a creative session and behavior, and should be left outside the room.

Thinking, Problem Solving and Creativity: An Overview

5.2 Thinking, Problem Solving and Creativity: An Overview

A review of the literature on thinking and problem-solving reveals a variety of theoretical orientations and a whole host of experimental investigations. To sift through this mass of data is a separate task in and of itself. Consequently, we shall focus on one specific aspect of the thinking-problem-solving dimension. This is the area referred to as creativity or creative problem-solving.

In order to orient ourselves, we must briefly consider the semantics of the word. At present, investigations reveal the existence of some 50 or 60 definitions and the list is expanding every day. **Sternberg**

examined the many definitions which have been offered, and classified them into six major groups or classes. These groupings are not mutually exclusive since each definition may contain elements which fall into different classes. The class into which a definition was placed was determined by the main theme of the definition.

The first class of definitions will be labeled **"Gestalt"** or **"Perception"** type definitions wherein the major emphasis is upon the recombination of ideas or the restructuring of a **"Gestalt"**. Certainly, **Wertheimer's** definition that creativity is the "process of destroying one gestalt in favor of a better one" belongs in this category. So also the definition of keep that it is "the intersection of two ideas for the first time" and **Duhrssen's** notion that it is the "translation of knowledge and ideas into a new form" belongs in this category.

The second class of definitions may be called **"end product"** or **"innovation"** oriented definitions. A representative member of this class is **Stein's** definition that "Creativity is that process which results in a novel work that is accepted as tenable or useful or satisfying by a group at some point in time". Even Webster's dictionary is oriented in this direction for "to create" is defined as "To bring into being", "To produce as a work of thought or imagination". **Harmon** prefers to speak of it **as "Any process by which something new is produced** – an idea or an object, including a new form or arrangement of old elements".

A third class of definitions can be characterized as **"Aesthetic"** or **"Expressive"**. The major emphasis here is upon self-expression. The basic idea seems to be that one has a need to express himself in a manner which is unique to him. Any such expression is deemed to be creative. Hence we have Lee's definition that **"The creative process can be defined as ability to think in uncharted waters without influence from conventions set up by past practices."** In this vein, he offers that "The creative process is the person, the creator, working through his creation". **Northrop** sees the essence of creativity as being the **"decision to do something when you are irritated". Thurstone** thinks of it in terms of problem sensitization and **Ghiselin** defines it as "The process of change, of development, of evolution, in the organization of subjective life".

A fourth class of definitions can be characterized as **"psychoanalytic"** or **"dynamic"**. In this group, we find creativity defined in terms of certain interactional strength ratios of the id, ego and superego. In this respect, **Bellak** assumes that all forms of creativity are permanent operant variables of personality and he subscribes to the notion that to be creative, the ego must regress in order for preconscious or unconscious material to emerge. Leading proponents of this type of definition are **Anderson, Kris and Kubie**.

A fifth class of definitions can be grouped under the classification of **"Solution Thinking"**. Here, the emphasis is upon the thinking process itself rather than upon the actual solution of the problem. Spearman, for instance, defines creativity in terms of correlates. That is, creativity is present or occurs whenever the mind can see the relationship between two items in such a way as to generate a third item. Guilford on the other hand, defines creativity in terms of a very large number of intellectual factors. **The most important of these factors are the discovery factors and the divergent-thinking factors.** The discovery factors are defined as the "ability to develop information out of what is given by stimulation." The divergent thinking factors relate to one's ability to go off in different directions when faced with a problem. This is similar to **Dunker's** notion that in order to solve a problem one often must move tangentially from common types of solution. Other proponents of this class of definitions are **Poincare and Wallas**.

The sixth and last class of definitions is labeled **"Varia"** simply because there **is no easy way of characterizing them.** There is, for instance, **Rand's** definition that creativity is the **"addition to the existing stored knowledge of mankind"**. **Lowenfeld** speaks of it as the result of our subjective relationship with man and environment. **Porsche** sees it as the integration of facts, impressions, or feelings into a new form. Read feels that it is that quality of the mind which allows an individual to juggle scraps of knowledge until they fall into new and more useful patterns and **Shepard** speaks of it as a destructive process much like Wertheimer when he spoke of creativity in terms of destroying one Gestalt in favor of another.

Integration and Conclusions: Creativity a Field of Creativity

5.3 Integration and Conclusions: Creating a Field of Creativity

Psychologists discussed creativity in many different ways. Different levels of analysis were used to address the concepts; within levels, different components were put forth; and even when similar components were discussed, differences were seen in how these components were defined and how crucial they were claimed to be for the larger concept of creativity. Given these differences, which are as varied as creative expression itself, one might ask if there is any consensus whatsoever, if we know anything at all about creativity, or if it is even a useful concept for scientific theory and research. Our response, parallel to those of the preceding authors, is that despite the differences, there exist major areas of agreement, and although many refinements are necessary, creativity is an essential concept for psychology and holds enormous potential for scientific investigation.

What we shall attempt to provide, therefore, is a consensual summary of these many varied explanations of creativity, listing the major agreements and highlighting some of the more controversial

issues. The organization of this summary will follow **Stein's** general approach to dissecting the problem of creativity. That is, views of creative processes, persons, products, and places (problem domains and socially organized fields of enterprise) will be discussed in detail.

Creative Process

5.3.1 Creative Processes

In general, psychologists have viewed creativity **as a process existing in a single person at a particular point in time.** Some other authors, however, present a new alternative to this view. **Csikszentinilialyi, Gardner, Gruber and Davis, and Hennessey and Amabile** represent the new view and discuss creativity as **existing in the larger system of social networks, problem domains, and fields of enterprise,** such that the individual who produces products that are judged to be creative is only one of many necessary parts. This systems view of creative processes does not preclude the individual view, however. Rather, it provides additional insights regarding creative persons and products and their function in society as a whole. Our initial focus, therefore, will be to outline some understandings of the process within the individual before going on to the systems approach.

By far the greatest amount of agreement is with the statement that creativity takes time. In fact, some authors believe that the very nature of creativity depends on **the time constraints involved and the opportunity to revise, or nurture, the outcomes once produced.** Although not all theorists emphasize time to the same extent, the creative process is not generally considered to be something that occurs in an instant with a single flash of insight, even though insights may occur.

Instead of focusing on instantaneous insights, then, **Barron** and **Torrance** compare the process of creativity to procreation and emphasize the long gestation period that is required after the initial conception of an idea. Another process to which creativity has been compared (which also emphasizes time) is the more general and even lengthier process of evolution, in which the surviving products are determined through natural selection from a multitude of random variations.

Barron, Csikszentiniilialyi, Gardner, Gruber and Davis, Perkins, Sternberg, and Walberg all suggest that creative processes involve an active search for gaps in existing knowledge, problem finding, or consciously attempting to break through the existing boundaries and limitations in one's field. On the other hand, **Feldman, Johnson-Laird, Langley and Jones, Simonton, and Taylor** suggest that creative products are outcomes of random variations at either the generative or selection stage in creative processes. A further alternative, intermediate between chance-dependent and completely intentional processes, is an approach that is also taken by

several of the authors. Specifically, creative processes may be seen as initiating from a previous failure to find explanations for phenomena or to incorporate new ideas into existing knowledge, or form a general drive toward self-organization through the reduction of chaos.

In addition to asking about origins, one might also ask about differences between the products of creative processes. Does the particular product or the domain in which creativity occurs affect the process itself, just as different children or different species may develop at different rates and perhaps go through unique series of stages? Although several authors claim that creativity is domain-specific, there are some claims for universals in creativity, as there are for development and evolution. Thus, several general characteristics of creative thinking, regardless of domain, have been proposed.

For example, creative thought processes, regardless of the problem on which they are focused, are claimed to involve the following: transformations of the external world and internal representations by forming analogies and bridging conceptual gaps; constant redefinitions of problems; applying recurring themes and recognizing patterns and images of wide scope to make the new familiar and the old new and nonverbal modes of thinking.

In addition to time requirements, some element akin to insight, and the generality of processes across domains, a further issue on which several authors agree is that different levels of creative expression may occur. Although not all authors have addressed the levels issue explicitly, the general belief is that the processes responsible for varying levels of creativity may differ, if not in kind, at least in degree; see **Feldman** for a more detailed discussion. Thus, both within a domain and within the same individual at different points in time, there may be differences with respect to the amount of creative processing in which individuals engage. **Einstein**, in this view, may have attained a high level of creativity, or often have engaged creative thought processes, whereas a less influential scientist in his time may not have achieved such a high level, or simply did not apply creative processes to the same extent that **Einstein** did. Different levels of creativity may exist, therefore, in an analogous fashion to the idea that species differ in their complexity along the phylogenetic scale. However, this issue of levels brings up yet another area of controversy: the availability and accessibility of creative processes, both between and within individuals.

First, let us address the availability question, as it pertains to different individuals. **Creativity,** according to some authors, occurs only in special individuals (the **Edisons, Einsteins, Freuds, Mozarts, and Picassos of the world)** at rare moments in time. Other authors believe creativity to be a much more normative process, available to

every thinking instrument - adult expert, growing child, or programmed computer. Thus, creative processes can be trained and improved, as far as Langley and Jones, Schank, Taylor, and Torrance are concerned, because their concept of creativity is in line with this latter, **"available-to-everyone"** view. Training is not an easy matter, however, according to the theories of authors such as Barron, Csikszentmilialyi, Gruber and Davis, and Hennessey and Amabile, who maintain that creativity is achieved only when the "right" combination of particular problems, skills, individual, and social milieu comes together.

Finally, there is controversy over the accessibility of creative processes within individuals. **Disagreement** on the accessibility issue ensues when the role of the unconscious and semiconscious elements in creative processing are brought up. As with insight, the expression of the unconscious is sometimes conceived of as the key to creativity (Feldman; Torrance). Thus, creativity, according to these authors, is accessible only by bringing unconscious elements into conscious awareness. In other views, however, the role of the unconscious and the question of accessibility are ignored completely. Once again, the consensus lies in between, with unconscious elements existing and being important for creativity, but not the essence of creative thought processes. Langley and Jones, for instance, provide a particularly interesting discussion of the unconscious in the memory-activation processes. In the Langley and Jones proposal, the memories relevant to a creative insight are not accessible until just the right cue activates them. Thus, they propose that such unconscious processes are involved in, but are not central or unique to, creativity.

The issues addressed when one considers creative processes, therefore, include the following: the time required for such processes; the role of insight and the sparks that set off creative thinking; how closely processes are tied to their products; general characteristics of creative thought across different domains; levels of creative processing; the need for the products of such processes to be unique in order for them to be labelled as creative; and how accessible and controllable the processes are in conscious awareness.

Creative Persons

5.3.2 Creative Persons

Descriptions of the creative person typically fall into three general categories: cognitive characteristics; personality and motivational qualities; special events or experiences during one's development. We shall discuss each category in turn.

It is generally acknowledged that **people are creative within particular domains of endeavor,** even though people who are creative in different domains may share common traits. Thus, one may be a creative biologist, but a very uncreative novelist, or vice

versa. This is a curious statement, given that when the issue of domain specificity occurs in discussions of creative processes, much less agreement ensues. Nonetheless, domain specificity is a major consideration when describing creative persons, and it goes along with other characteristics such as using one's existing knowledge in the domain as a base to create new ideas, being alert to novelty, and finding gaps in domain knowledge. Although, it is generally agreed that creative individuals are creative within limited domains, various explanations have been offered for why individuals differ in their propensities toward and abilities in their domains of specialty. Csikszentinitialyi, Gardner, Perkins, and Walberg, for instance, attribute such specificities to inborn sensitivities to particular types of information or modes of operation. Gardner and Gruber and Davis, however, discuss unique combinations of intelligences, whereas Walberg emphasizes highly practiced skills as a factor.

A list of cognitive characteristics that are shared by creative people, regardless of domain, can be grouped into three sets: traits, abilities, and processing styles that creative individuals use and possess.

First, there are the four traits that are commonly said to be associated with creative individuals: relatively high intelligence, originality, articulateness and verbal fluency, and a good imagination. **The next set of characteristics that have been used by creative persons includes the following cognitive abilities:** the ability to think metaphorically, flexibility and skill in making decisions, independence of judgment, coping well with novelty, logical thinking skills, internal visualization, the ability to escape perceptual sets and entrenchment in particular ways of thinking, and finding order in chaos. **Finally,** creative people may also be characterized by the way in which they approach problems (i.e., style); some of the most commonly mentioned processing styles include using wide categories and images of wide scope, a preference for nonverbal communication, building new structures rather than using existing structures, questioning norms and assumptions in their domain (asking “Why?”), being alert to novelty and gaps in knowledge, and using their existing knowledge as a base for new ideas.

The one characteristic that seems to prevail among creative people, however, is what seems almost to be an aesthetic ability that allows such individuals to recognize “good” problems in their field and apply themselves to these problems while ignoring others (**Perkins**; **Stemberg**; **Walberg**). What accounts for this sense of aesthetic taste and judgment? Perhaps it is some combination of the foregoing characteristics, perhaps it is better explained by the personality or motivational characteristics to be presented next, or maybe it is a separate factor altogether. Whatever the particular explanation, this aesthetic sense is clearly a pervasive feature of creative persons and one that is worthy of greater study, not just in the arts, in which we

think of aesthetics as being of primary importance, but in a variety of domains, including scientific areas, in which we do not usually think of aesthetics as playing an important role, at least when investigated superficially.

As with the cognitive characteristics, there is no one personality or motivational characteristic that is useful for attaching the label -creative- to a particular person. Rather, creative personalities are composed of a constellation of many characteristics, some of which may be present in one creative individual, but not in another, and thus mentioned by some authors, but not others. The most commonly mentioned characteristics include a willingness to confront hostility and take intellectual risks, perseverance, a proclivity to curiosity and inquisitiveness, being open to new experiences and growth, a driving absorption, discipline and commitment to one's work, high intrinsic motivation, being task-focused, a certain freedom of spirit that rejects limits imposed by others, a high degree of self-organization such that these individuals set their own rules rather than follow those set by others, and a need for competence in meeting optimal challenges; though often withdrawn, reflective, and internally preoccupied, creative individuals are also said to have impact on the people who surround them.

Additional characteristics that were mentioned less often yet are still considered to be important features of creative personalities, **were tolerance for ambiguity, a broad range of interests, a tendency to play with ideas, valuing originality and creativity,** unconventionality in behaviour, experiencing deep emotions, intuitiveness, seeking interesting situations, opportunism, and some degree of conflict between self-criticism and self-confidence.

In addition to the **conflict between criticism and confidence**, there appears to be a conflict or paradox between socially withdrawn and socially integrated tendencies; at least this appears to be the case when we consider the comments from those authors who discussed how creativity and creative individuals function in social environments. For instance, it was mentioned previously that creative people have impact on others in their immediate surroundings. However, **Feldman and Gardner,** both suggest that what distinguishes creative individuals is their lack of fit to their environment. Similarly, others have discussed creative people's need to maintain distance from their peers, an avoidance of interpersonal contact, and resistance to societal demands. Back on the other side, it has also been proposed that creative individuals have a drive for accomplishment and recognition, a need to form alliances, desire attention, praise, and support, are charismatic, display honesty and courageousness, are emotionally expressive, and are generally ethical, empathetic, and sensitive to the needs of others. The conflict between social isolation and integration, then, is yet another issue that would be brought into clearer focus if investigated directly.

The final light in which to consider creative individuals is with respect to their developmental histories. Such histories were primarily elucidated by **Gruber and Davis, Simonton, and Weisberg,** although some aspects of development were also discussed by **Csikszentinitalyi, Gardner, Perkins, Sternberg**, and **Torrance**.

Being a firstborn, having survived the loss of one or both parents early in life, experiencing unusual situations, being reared in a diversified, enriching, and stimulating home environment, and being exposed to a wide range of ideas are some of the early experiences and demographic characteristics that were mentioned by **Simonton**, **Csikszentinitalyi, Weisberg, Walberg**, and **Gardner**, respectively. Creative adults, while children, have also been cited as being happier with books than with people, liking school and doing well, developing and maintaining excellent work habits, learning outside of class for a large part of their 'education', having many hobbies, being omnivorous readers, and forming distinct and closely knit peer groups, yet perhaps also exhibiting marginality. Once again, the tension between social isolation and integration appears.

Having a future career image and definite role models, mentors, and paragons while in training are features put forth by **Simonton, Torrance, Walberg, and Weisberg** as important factors influencing the development of creators in many fields? Moreover, over the course of their careers, creative individuals exert sustained effort and hence enjoy enduring reputations, have contributions that demonstrate precocity and longevity publish early and get good jobs at the initial stages, and, overall, demonstrate voluminous productivity.

Studies of creative people, more than any other approaches to research in creativity, are in dire need of some good controls. Such control studies might, for instance, include experiments that examine people with differences in the relevant characteristics beforehand, not after their creativity has already been assessed.

5.3.3 Creative Products

Creative Products

Reflecting psychology's emphasis on laboratory studies, the most frequently discussed products of creative thought are solutions to problems, responses on creativity tests, and explanations for phenomena. Close behind come technological inventions and artefacts, novel ideas, and new styles, designs, or paradigms. Although of more interest to the layperson when thinking about creativity, the fine arts (painting, sculpture, and music) received only half as much attention from the authors as scientific and laboratory problem solving. There are the expressions of emotions and abstract ideas, the performing arts of dance and drama, occupations such as advertising and marketing, and other media such as photography and film.

An important question concerning products, as it is for processes, is whether or not any generalizations can be made about products that are judged to be creative across different domains. The most obvious statement is that creative products are novel - they are not imitations, nor are they mass-produced. Other requirements of such products are that they are powerful and generalizable, exhibit parsimony, cause irreversible changes in the human environment, may involve unusual sensory images or transformations, and are valuable or useful to the society, or at least the restricted domain, in which they were formed.

Some features that may be more relevant to scientific creativity and creative problem solving are that the products should show sensitivity to gaps in existing knowledge, cross disciplinary and within-discipline boundaries so that they are difficult to categorize, be surprising, and be correct, in that experts agree on the produced solution. In addition, they may be difficult, initially vague, or ill-defined and involve coherent syntheses of broad areas. Torrance's criteria, which include showing humour, fantasy, colour, and movement, in both literal and metaphoric senses, probably are more relevant to the arts and specific tests of creativity than they are to science.

5.3.4 Creative Places (Domains, Fields, and Contexts)

Creative Places (Domains, Fields and Contexts)

Three ways that a field can be thought of as affecting creativity are via the general contributions and resources available to individuals within the field, through the special effects a particular field may have on its domain and the nature of the creative expressions that result, and by containing specific characteristics that either promote or inhibit creativity.

Wealth an audience's attention, educational and employment opportunities, background knowledge, styles and paradigms, cues for insights, roles, norms, and precedents, and good teachers have all been cited as contributions relevant to the creativity expressed in particular domains, individuals, and processes. Further, fields provide peers to evaluate and confirm creativity in their domains while also protecting and freeing the development of creative products and individuals from the less congenial evaluations that may come from members of the general public. Stimulation and sustenance of creative processes, as well as preservation and selection of ideas have also been proposed as necessary components of any field in which creative endeavour occurs. According to **Hennessey and Amabile**, fields also affect the motivation of individuals working within them.

Csikszentinitalyi makes two claims that address a small part of the question regarding features of creativity-inducing fields, provided that evaluation of products is seen as important in creative expression. First, he suggests that a field's internal organization is

one factor that attracts interested neophytes to a particular field rather than others. Second, he claims that the ease of evaluation in various domains, and hence agreement among experts as to who and what are going to be defined as creative, is determined by the precision of notational systems within the domains. Other ways that a field can improve its likelihood of creativity, as suggested by **Torrance**, are by using sound effects to stimulate creative images and by providing warm-up exercises that are designed to free the imagination, although these techniques probably are more relevant to some types of creativity than to others.

Now look at the differences between the creative individual and creative organizations, see Table 5.1.

Table 5.1: The creative individual and organization

The Creative Individual	The Creative Organization
Conceptual fluency… is able to produce a large number of ideas quickly.	Has idea men Open channels of communication Adhoe devices: Suggestion systems Brain-storming Idea units absolved of other responsibilities Encourages contact with outside sources Heterogeneous personnel policy
Originality… generates unusual ideas	Includes marginal, unusual types Assigns non-specialists to problems Allows eccentricity Has an objective, fact-founded approach
Separates source from content in evaluating information… is motivated by interest in problem… follows wherever it leads	Ideas evaluated on their merits, not status of originator Adhoe approaches: Anonymous communications Blind votes. Selects and promotes on merit only
Suspends judgment… avoids early commitment… spends more time in analysis, exploration.	Lack of financial, material commitment to products, policies Invests in basic research; flexible, long-range planning Experiments with new ideas rather than prejudging on "rational" grounds; everything gets a chance
Less authoritarian… has relativistic view of life	More decentralized; diversified Administrative slack; time and resources to absorb errors.

Accepts own impulses… playful, undisciplined exploration **Independence of judgment**, less conformity Deviant, sees self as different Rich, "bizarre" fantasy life and superior reality orientation; controls.	Risk-taking ethos… tolerates and expects taking chances. Not run as "tight ship" Employees have fun Allows freedom to choose and pursue problems Freedom to discuss ideas Organizationally autonomous Original and different objectives, not trying to be another "X" Security of routine… allows innovation "Philistines" provide stable, secure environment that allows "creators" to roam. Have separate units or occasions for generating vs. evaluating ideas… separates creative from productive functions.

Innovative & Creativity at Work

5.4 Innovation & Creativity at Work

Organizations today are the **'primary crucible for human development'.** As such they have a great influence on humankind's future development, for better or worse. Much has been said and written about organizations from an external, structural point of view: how they should define their business mission, set their strategies for differential advantage, design their structures and objectify their tasks, to assure the efficient and successful attainment of their economic goals. Indeed, this is how we have tended to think of business: **as an external structured mechanical approach to attainment of tangible economic goals.** Recently, however, questions have been arising about the internal, less tangible side of our organizations: why does the organization have the purpose it does, what values are inherent in its purpose, how are these values manifested in its culture, and how does this culture affect the motivation and contribution of its employees to the company's purpose? This questioning has spurred the scientific inquiry by the behavioral sciences toward a better understanding of this cultural side of organizations.

At the same time as the above trend, the need to increase creativity and innovation in our organizations has emerged. Driven by the globalization of competition, and the increased pace of change in the situation around them, organizations are questioning whether their products or services are sufficiently innovative to meet the needs of the changing environment. On contemplation of the need to increase creativity and innovation, it becomes apparent that faster, smarter technology will not be enough. The creativity of the human being must be enhanced as well. Thus the question before the organization is

how do we increase the creativity of our employees?

These two streams of inquiry, how we can understand the contribution of our culture to the achievement of our company purpose, and how we can increase our creativity, come together in the question: how does the culture of an organization affect the creativity of its employees?

This question has been the focus of a research effort by **the Centre for Creative Leadership (CCL) and Dr Teresa Amabile of Brandeis University.** Dr Amabile is well known for her research into the effect of the social environment on the creativity of the individual. Her research has documented a **link between the social environment around an individual and the creativity of the individual's work output.** The link is the effect the social environment has on the intrinsic motivation of the individual. One does one's most creative work when one is primarily motivated by the enjoyment of the task itself, and not by extrinsic motivators. Thus the basic theory underlying the CCL research is that organizations can increase their employees' creativity by shaping a social environment that encourages the inner motivation of the employee to emerge and engage with the work task.

The CCL research has had two goals: to identify and measure the factors in organizational climates which affect employee creativity, and to provide an organizational intervention methodology which makes this information useful to organizations which desire to improve their climates for creativity i In this research design, Dr. Amabile provided the theoretical and empirical expertise, while CCL provided the client interface and the organizational intervention expertise, see Table 5.2.

Table 5.2: Centre for creative leadership: brief descriptions of the WEI factors with sample items from each scale

Stimulants to Creativity	**STIMULANTS TO CREATIVITY**
Coworkers	**Coworkers** Teamwork, willingness to help each other, commitment to the work, and trust with fellow workers. In my work group, people are willing to help each other. The people in my work group are committed to our work.
Resources	**Resources** Access to appropriate resources, including facilities, equipment, information, funds, and people. The facilities I need for my work are readily available to me. Generally I can get the resources I need for my work.
Challenges	**Challenge** Challenge due to the importance of the work and the intriguing nature of the task. I feel that I am working on important projects.

	The tasks in my work call out the best in me.
Freedom	**Freedom** Freedom in deciding how to accomplish the task. A sense of control over one's work and ideas. I have the freedom to decide how I am going to carry out my projects. In my daily work environment I feel a sense of control over my own work and my own ideas.
Supervisor	**Supervisor** A manager who gives support to subordinates, communicates effectively, and sets clear goals. My supervisor clearly sets overall goals for me. My supervisor values individual contributions to project(s).
Creativity supports	**Creativity supports** Encouragement and support for creativity from top management; mechanisms for developing creative ideas in the organization. In this organization top management expects that people will do creative work. People are encouraged to take risks in this organization.
Recognition	**Recognition** The existence of rewards and recognition for creativity in the organization. People are recognized for creative work in this organization. People are rewarded for creative work in this organization.
Unity and cooperation	**Unity and cooperation** A shared vision within the organization and a cooperative and collaborative atmosphere. There is a generally cooperative and collaborative atmosphere in this organization. Overall, the people in this organization have a shared 'vision' of what we are trying to do.
OBSTACLES TO CREATIVITY	**OBSTACLES TO CREATIVITY**
Insufficient time	**Insufficient time** The lack of time in which to consider alternative ways of doing the work. I have too much work to do in too little time. We do not have sufficient personnel for the project(s) I am currently doing.
Status quo	**Status quo** The reluctance of managers or co-workers to change their way of doing things, a generally traditional approach. There is much emphasis in this organization on doing things the way we have always done them. Management avoids controversial ideas in this organization.
Political problems	**Political problems** Lack of cooperation between areas of the organization, and battles over turf issues. People in this organization are very concerned about protecting their territory.

Evaluation pressure

There are many political problems in this organization.

Evaluation pressure

Perceived inappropriate evaluation or feedback systems or environment focused on criticism and external evaluation.

People are quite concerned about negative criticism of their work in this organization,

People in this organization feel pressure to produce anything acceptable, even if quality is lacking.

CRITERION SCALE (OVERALL RATING BY EMPLOYEES)

Creativity

Productivity

CRITERION SCALE (OVERALL RATING BY EMPLOYEES)

Creativity

How creative the organization is overall.

Overall my current work environment is conducive to my own creativity.

My area of this organization is creative.

Productivity

How productive the organization is overall.

My area of this organization is effective.

Overall this organization is productive.

Can organizations Show Creative Characteristics ?

5.5 Can Organizations Show Creative Characteristics?

During recent years, ***Caluin W Taylor*** *has given numerous speeches on whether organizations can show creative characteristics.* In his writings, **he has asked many questions such as: Should we ask organizations to display the same creative characteristics that are found in creative individuals?** For example, should organizations be alert and responsive to opportunities? Should they sense problems that haven't been sensed before and face up to these problems and try to do something about them, especially in the way of a diversity of fresh attempts toward better solutions, rather than ignore or postpone them for future generations ?

Can an organization learn to set the climate so that the inner resources of its people may be more fully developed and utilized? Can an organization have the characteristic of welcoming long strides of progress instead of only being able to tolerate inching ahead? Can an organization learn to adjust to ideas from its people so that both will work together, or will they tend to pull in different directions with the result that many of the good ideas may get killed and, as a result, the organization may also show signs of dying?

As an organization grows older, does it lose some of its potential by building into itself certain self-imposed restrictions and limitations in the process of developing its own set of intellectual and personality characteristics? Or does it develop creative characteristics so that it retains its creative potential and even increases its effective creative

mind power? Does it develop the characteristic and principle that its system is made for man, or is its guiding principle that man is supposed to be made for the system? Does it require its workers to adjust to its organizational environment, or does it allow and even encourage workers to adjust their own environment and build a better climate and organization for creative work?

Here are some answers of these questions

Here are some answers of these questions

Taylor says: "I have often wondered who the greatest killers of creativity were. At present, my strong conviction is that the person himself is the greatest killer of his own ideas. But if he doesn't kill his own brain-child and sends it out into the world, there will be plenty of other people ready to finish the job by killing it for him. One also wonders which is more effective in destroying ideas within itself: an individual or an organization."

While Richardson states that: "The new-idea man may have to exert pressure and strain on the system in order for the system to change enough to allow the new idea in; otherwise, inertia will tend to cause the system to settle back into its old rut. I was fascinated to hear that an organization was planning a meeting to lean how to avoid settling into ruts and, instead, to keep itself young and alive and thriving. They have dubbed this proposed meeting as a "dry rot" conference."

Since the crucial part of organizations are the people in them, one of **Taylor's** recent hunches is that an organization will be no more flexible than its least flexible link (of importance), and that it will be no more creative than its least creative link (of importance). In other words, one inflexible person in the right place can level the entire organization down toward his low degree of flexibility. Likewise, one uncreative person in a key position will tend to lower the creativity of the organization to his own level.

Richardson's idea, about keeping an organization alive and thriving, is that you must have a system which will spot and cultivate and insist upon having creative minds continue to rise to the top. One of his staff reported that there are four stages in the life of an organization as it starts out like a newborn baby with all the potential in the world. It is formed by (1) a group of leaders who could be called "**innovators**", who, in turn, tend to be replaced by (2) a group of leaders called "**developers**", who, in turn, make their contribution and tend to be succeeded by (3) a group of leaders called "**consolidators**", who, in turn, tend to prepare the organization and deliver it into the hands of (4) a group called "**undertakers**". The last dying gasps of a corporation are when its leaders decide to write "a bigger and better rule book". Under the reign of consolidators, what chance do creative minds have of giving the organization the "lifeblood of tomorrow" and of helping the organization not only to stay in the mainstream today,

but even create the mainstream of tomorrow? That is, when an organization is in the hands of consolidators, “what chance does a creative mind have to rise to the top?” And what chance would anyone ever have of reversing the above trend across leader types?

In case a person encounters some hindering features in the organization that were built-in earlier by someone else in order to get control over other creative individuals, he may encounter resistance in trying to get these restricting rule or features removed. He can inquire as to when they were built-in and how did it all happen? He could ask what would be necessary to restore the organization to its earlier state where it still had potential to do all these things. But if he can get rid of the hindrances, the workers might be able to do even better work than at present. To bring about the changes he may have to keep a strain on the system that will only relax when he leaves or when it changes – and it will sometimes bitterly resist the latter. Some key people, unfortunately, may see this pressure as a power struggle, rather than a struggle for ideas to get a chance. A struggle between people for power is distinctly different from a struggle “for ideas to have a hearing.” This is like the difference between a person in revolt and a revolutionary. One is after power and the other is after having his ideas heard. If the ideas are given a good hearing, the latter one, but not the former may relax the pressure.

To show the various reactions of leaders to different types of workers, Taylor have sometimes described persons in leadership positions as falling into one of four types. The first type he calls a “creative leader”, in the sense that he has all the creative characteristics and is blazing new trails and opening new fields so many people can follow into these new fields to work – he is really a pioneer. A second type is not quite this kind, but at least he might be called a creative leader in the sense of being a catalyst and thus being somewhat of a party to, though not the real creator of, the new ideas generated in others. So he does enter into the process as a catalyst and deserves credit for an assist. The third type is a creative leader in another sense; he can at least allow or tolerate or even encourage creativity in others around him and thereby create a more favorable climate. And the fourth type, he calls “none of the above”.

Taylor also classifies workers into four types to set the stage for another point. **One type** may be a worker with hardly any ideas, so that what he does is almost entirely what he is told to do. The **second one** may be someone with lots of ideas and he tries them out but quickly realizes that ideas are not “welcome here”. So he goes underground with his own ideas and becomes, in effect, a “yes man”. A **third type** is one who tries his ideas out and, when he finds that they aren’t welcome, explodes and quits. But the question is where does he go or where can he go? He goes someplace else and great creativity may occur when the administration explains why he left. He probably leaves some psychological scars behind, so that thereafter

the chances are reduced for idea persons like him ever being hired into that organization again. The **fourth kind** of worker is one who has ideas that he believes are needed for the organization to survive and thrive. He, therefore, stays and fights for his ideas.

Organizational Creativity and Innovation

5.6 Organizational Creativity and Innovation

Creativity and innovation (C&I) are widely recognized as important aspects of human functioning at all levels - individual, group, organizational, and societal. Over the last four decades, researchers and theorists from psychology **(e.g., Guilford),** sociology **(e.g., Merton)**, economics **(e.g., Mansfield)**, and many other disciplines have written about the causes and consequences of C&I in a variety of settings.

C&I are generally considered important for a healthy national economy and for increasing the quality of life. To meet the future needs facing the world, large investments of resources will be required to produce and implement creative solutions. However, because of the way societies are structured, much of the impetus for C&I will have to originate within complex organizations.

Of all the areas studied in relation to C&I, complex organizations have received considerable attention. Much of this attention can be attributed to the needs and values of organizational researchers. However, organizations themselves clearly have a stake in C&I research. Organizational growth and even survival can be tied directly to an organization's ability to produce (or adopt) and implement new services, products or processes.

The literature is replete with case studies detailing how organizations that ignored new technological advancements, for example, began a slow death spiral. Starbuck describes one case involving a manufacturer of mechanical calculators that refused to acknowledge the competitive impact of electronic calculators. The result was predictable: profits declined steadily until the company was bought out and restructured to emphasize electronic calculators.

In spite of the importance attributed to organizational C&I, the empirical research has been somewhat spotty and less than conclusive. After reviewing close to 100 major books and articles on organizational C&I, ***Gundy found that at least ten general conclusions can be drawn:***

1. The terms **"creativity"** and **"innovation"** often are used interchangeably, thus making comparative distinctions difficult. Publications that do make a distinction frequently lack agreement on how to define creativity and innovation.

2. **The majority of the empirical research literature deals exclusively with organizational innovation.** The literature identifying itself with organizational creativity is largely nonempirical and concerned mostly with prescriptions for needed climate variables (e.g., Cummings, 1965). The majority of empirical creativity research is limited to studies of intragroup creativity (e.g., the literature on brainstorming) and personality traits and characteristics of individuals.
3. **Most of the research on organizational innovation deals either with the adoption or individual diffusion of innovations.** Very few large-scale studies of entire innovation process exist.
4. **The focus of most innovation research** has involved correlating structural aspects of organizations with composite measures of innovation.
5. **Unitary models of innovation** have dominated previous research. This research has largely ignored the existence of organizational C&I occurring within different organizational subsystems at different times. Instead, some research studies seem to assume that organizations are either innovative or they are not.
6. **Innovation typically** is considered to be a positive attribute of organizational functioning. Although this view probably reflects die values of many researchers, the negative aspects of innovation also are important for understanding the innovation process.
7. **The broad study of organizational innovation** as a process similar to all organizations is giving way to the study of specific innovations in specific organizations.
8. **In most organizations**, the innovation process is more evolutionary than revolutionary. Most innovations are diffused, and implemented at a relatively slow pace. Radical innovations are rare, but do occur when conditions warrant them (e.g., during situations perceived as survival threatening, or what **Knight** refers to as "distress innovations").
9. **Organizations designed along bureaucratic lines** are highly resistant to innovations and often fail to foster conditions conducive to creativity. Alternative organizational structures (such as matrix systems) and new managerial philosophies, however, are helping to counteract this resistance.

Creativity versus Innovation

5.7 Creativity versus Innovation

A distinction needs to be made between creativity and innovation to clarify some differences that exist in the literature. Except for a few researchers, definitions of organizational innovation have excluded any mention of creativity or idea generation. ***For example,*** organizational innovation has been defined as "first or early use of an idea by one of a set of organizations with similar goals", “the adoption of means or ends that are new to the adopting unit", the adoption of a

change which is new to an organization and to the relevant environment, "an idea, practice, or object that is perceived as new by an individual or other unit of adoption", and "adopted changes considered new to the organization's environment".

Reviewing these definitions and others suggests that organizational innovation is: (1) change perceived as new to an organization, (2) something new that is adopted for use by an organization (with the implication often being that implementation will follow adoption automatically), and (3) relative to the organization adopting and using something new; what is innovative for one organization may not be innovative for another.

Organizational creativity, on the other hand, often is used to mean the same thing as organizational innovation. This usage is especially evident in the nonempirical writings on organizational creativity. Most of this work neglects to define organizational creativity precisely. However, it usually can be inferred that the writers view organizational creativity as representing the sum total of the creative traits, abilities and actions of all the organization's members. It also can be inferred from this literature that an organization will be creative if the proportion of creative individuals (and their creative acts) exceed the proportion of "noncreative" individuals.

It can be assumed that **all individuals in organizations are creative and vary only in the degree of their creativeness,** and then all organizations must be considered creative. Furthermore, just as some individuals are more creative than others, some organizations should also be more creative than others. It would then follow that a creative organization is likely to be more successful at innovation than a less creative organization. That is a highly creative organization should be better able to initiate, adopt, and implementt new products, services, or processes.

As conceptualized by many writers in the field, creativity might be viewed more realistically as a problem solving process with identifiable stages. One of these stages happens to be idea generation. But achievement of creative solutions cannot always be accomplished through idea generation alone, other activities such as data-finding and problem-finding also are important.

It probably is most realistic to **view creativity as a process that cuts across all aspects of the innovation process**. Idea generation may be used in some stages of the process at different times and within different subsystems of a particular organization. However, other stages of the creative problem-solving process also may assume equal or greater importance depending upon the needs and perceptions of individual innovators within an organization.

In some instances, an organization may generate idea proposals internally or it may decide to adopt externally-generated proposals. In either case, some degree of creative problem solving may be involved. For example, a decision to adopt an externally-generated proposal may produce new problems for an organization, any of which may require development of creative solutions. Thus, innovation and creative problem-solving processes are closely intertwined. It is very difficult to consider one without considering the other.

For our present purposes, the innovation process will be viewed as consisting of the following stages: (1) problem awareness and identification, (2) idea proposal, (3) idea adoption and (4) idea implementation. **Such a process is very similar to the basic Osborn-Parnes five-step creative problem-solving model of fact-finding, Problem-finding, Idea-finding, Solution-finding, and Acceptance-finding**.

Based upon this four-step model, organizational innovation will be defined as the process of proposing, adopting, and implementing an idea (process, product, or service) new to an organization in response to a perceived problem. **This definition emphasizes that innovation: (1) is a continuous, dynamic set of activities (2) deals with the concept of newness relative to a particular organization and (3) is stimulated by a perceived gap in performance (a problem).**

The act of proposing an idea can involve idea conception (generation of an idea new to the organization) as well as the act of recommending that a borrowed idea be considered for adoption. In either instance, the idea may be new to the organization. The only difference is the source of the idea.

Chapter 6: Barriers to Innovation

Introduction

The characteristics, processes, attitudes, and behaviours in organizations that have hypothesized to impede innovation have received extensive attention in the literature. If barriers offer sufficient resistance, then innovations are not likely to be adopted or implemented. However, barriers can be a positive feature of the innovation process, since they often force innovators to plan ahead adequately and thus can help insure successful adoption and implementation.

Most of the barriers described next relate to bureaucratic disfunctions. Some will stick to certain stages of the innovation process, while others have significance throughout the process. Although many others could have been included, the ones chosen are fairly representative.

Gundy has organized the barriers into five categories: *(1) Structural, (2) Social/Political, (3) Procedural, (4) Resource and (5) individual.* Many of the barriers within these categories are interrelated. Consequently, the categories should be considered only rough approximations. As with most research, cause and effect determinations are difficult to make in innovation studies. For example, it is hard to tell if social norms "cause" structural arrangements or if structural arrangements cause social norms.

Structural Barriers

6.1 Structural Barriers

Major barriers in this category include: *(1) Stratification, (2) Formalization, (3) Centralization, and (4) Specialization.* In most cases, the extent to which a structural barrier will impede innovation depends upon the innovation stage involved. For example, some barriers may be problematic during the proposal stage, but not during implementation.

Stratification has been described in terms of distribution of rewards throughout an organization (Hage & Aiken, 1970) and degree of status, congruence and ease of intra organizational mobility. **Reasons for this inhibition have been attributed to:** (1) a preoccupation with status differences that diverts attention and energy from idea proposals, (2) perceived status differences create insecurity which reduces willingness to take risks, (3) an idea proposal may suggest reducing a status differential and would be resisted by those in high status positions, and (4) upward communication will be decreased due to fear of evaluation.

Formalization can be defined as, ***"the degree to which an organization emphasizes following rules and procedures in the role performance of its members".*** It is thought that formalization is detrimental to initiation of innovations, but favourable to adoption of innovations. If organizational members are expected to behave in prescribed ways and innovation is not prescribed, fewer idea proposals will be generated. However, the singleness of purpose that accompanies formalization can make it easier to adopt and implement new ideas.

The concentration of power and authority and their effect on participation in decision making will influence the degree to which an organization is centralized. Although there are some contradictory research results, **centralization** may be negatively related to idea proposals and positively related to adoption. The more that power is concentrated and the less the amount of lower-level participation, the fewer will be the number of ideas that trickle up. If too many high-powered individuals attempt to negotiate adoption, consensus is not likely to be achieved. Thus, centralization may inhibit initiation, but facilitate adoption. Moreover, centralization may encourage implementation.

Specialization (sometimes referred to as differentiation or complexity) typically is defined in terms of the degree of occupational variability that exists within an organization. When specialization is high **(and thus diversity and cross-fertilization of ideas should be high),** initiation of idea proposals and idea adoption will be facilitated. However, implementation may be inhibited due to potential conflicts, although there is some disagreement on this.

Social/political Barriers

6.2 Social/Political Barriers

These barriers pertain mostly to norms and power-related influences within organizations. Although accepted standards of behaviour and power may influence many organizational processes positively, some norms and power can have an influence upon innovation.

For example, many organizations have norms that reinforce conformity and engender a reluctance to **"rock the boat".** Other norms include such things as a tendency to minimize conflict (which often is required to develop new ideas), an attitude of secrecy and a reluctance to share ideas, a generalized fear of criticism, an attitude that entrepreneurial types don't fit in the organization, a fear that any major innovation will result in elimination of jobs, and a belief that an innovation would alter a perceived uniqueness about an organization ("we're already pretty special, so why should we change?").

Power influences that might negatively affect innovation include a general overemphasis on power relationships and status differentials (i.e., the organization as a political system), a reward system that discourages idea champions to help facilitate idea adoption and implementation, and a lack of professionalism at lower organizational levels.

Procedural Barriers

6.3 Procedural Barriers

Procedural barriers generally refer to policies, procedures, and regulations that often inhibit innovation. Also included in this category are certain procedures or managerial philosophies that, although not officially codified, nevertheless can exert a powerful negative influence.

Some examples of barriers in this category include: *(1) promoting executives on the basis of their analytical skills rather than their ability to build a creative climate, (2) emphasis on short-term planning, (3) a desire to avoid expenditures without a short-term payback, (4) an innovation that appears in conflict with existing laws, (5) a desire to protect the status quo, to not do things differently, (6) an overemphasis on an external reward system rather than internal commitment, (7) expecting/demanding orderly advance during the innovation process and emphasizing planning tactics more than the innovation, (8) exerting detailed control too early in the innovation process (Quinn, 1979) and (9) using unfamiliar jargon with decision makers.*

Resource Barriers

6.4 Resource Barriers

These barriers **apply to such things as people, time, money supplies, and information.** It is generally accepted that innovation will not prosper if resources are in short supply innovation requires a certain amount of slack resources beyond those needed for routine functioning. However, resources can act as a barrier even when some slack exists. Implementing an innovation frequently requires that resources be shifted from one area to another. This shifting can, in some cases, result in internal conflicts that can be very disruptive to the innovation process.

Individual/ Additional Barriers

6.5 Individual/Attitudinal Barriers

These barriers **reside within individual organizational members**, but also may stem, in part, from the organization's climate. **Fear of risk and failure and intolerance of uncertainty and ambiguity** are commonly-cited examples of these barriers. **Other barriers in this**

category would be individual characteristics that have the potential to create conflicts, thus stifling adoption or implementation. Basic differences in needs, values and perceptions would be typical examples. For instance, **Hage and Dewar (1973)** found that values of organizational elites who favor an innovation are predictive of innovation than are organizational structural variables.

An Organizing Framework

6.5.1 An Organizing Framework

As **Becker and Whisler** note, the innovation literature seems to be organized along the lines of simple systems elements: inputs, outputs, and processes. Inputs are variables that predispose organizations to innovate; outputs are types of innovations adopted and/or implemented; processes are sets of activities used to transform inputs into outputs.

The **inputs of structure, people, and information flow are somewhat analogous** to the open systems perspectives of structural design, human, and work flow. All three of these perspectives are interrelated such that a change in one can affect either of the other two perspectives. Gundy added the Environment input to reflect the dependency of organizations upon their environments and the crucial role that both internal and external environmental factors can have upon innovation.

Level or Style? (Kirton Theory)

6.6 Level or Style? (Kirton Theory)

Previous studies in the fields of decision-making and creative thinking have been dominated by concern with efficiency in solving problems and with the frequency with which effective ideas are produced: in other words, with the level of the intellectual process. Less attention has been paid to the different ways in which individuals approach problems or the strategies which consciously or unconsciously are adopted: in other words, to the style of problem-solving. It may be that a main reason for the continued domination of level over style has been that the two concepts have not been sufficiently separated and fit into an adequate theoretical framework. This accounts for, among other things, a plethora of terms but a lack of consistent expected relationships between measures and between measures and correlates.

For Cattell in his 16 Personality Factors, creativity (unspecified as to level or style) is a higher order factor, made up of a number of factors which relate to and correlate with style; however, he also includes an estimate of intelligence (Factor B) with double weighting for good measure. Surely IQ should be regarded as a correlate of level. His creativity factor correlates poorly with the adaptation-innovation inventory, and so, to almost exactly the same degree, does Jackson's Personality Inventory measure of Creativity.

Torrance's Right-Left Brain Hemispheric Preference conversely correlates highly with adaptation-innovation (nearly as highly as Myers-Briggs S-N and J-P combined). There seems no good reason why Hemispheric Preference should relate to IQ.

The adaptation-innovation theory proposed by **Kirton** does distinguish between level and style. If only by purporting to be solely concerned with style and unrelated to level.

Terminology

6.6.1 Terminology

Adaptation

Adaptation: Adaptation is **the characteristic behaviour of individuals** who, when confronted with a problem, **turn to the conventional rules, practices and perceptions of the group to which they belong** (which, may be, a working group, a cultural group or a professional or other occupational group), and derive their ideas towards the solution of the problem from these established procedures. When there is no ready made answer provided by the repertoire of conventional responses, then the adaptor will seek to adapt or stretch a conventional response until it can be used in the solution of the problem. Thus much of the behaviour under this heading is seen as making improvements on existing methods, or as Drucker puts it **"doing better-what is done already-a strategy which tends to dominate management."**

Innovation

Innovation: Innovation is the characteristic behavior of individuals who, when confronted with a problem, **attempt to reorganize or restructure the problem, and to approach it in a new light, free from any of the customary perceptions or presuppositions** which would be the conventional starting-point for its solution. Innovators thus produce answers which are less predictable and thereby sometimes less acceptable to the group; see Table 6.1. This approach can be described as “doing things differently” in contrast to the Adaptor's “doing things better. “

Table 6.1: Behavior descriptions of adaptors and innovators.

Adaptor	Innovator
Characterized by precision, reliability, efficiency, methodicalness, prudence, discipline, conformity.	Seen as undisciplined, thinking tangentially, approaching tasks from unsuspected angles.
Concerned with resolving problems rather than finding them.	Could be said to discover problems and discover avenues of solution.
Seeks solutions to problems in tried and understood ways.	Queries problems’ concomitant assumptions; manipulates problems.
Reduces problems by improvement and greater efficiency, with maximum of continuity and stability	Is catalyst to settled groups, irreverent of their consensual views; seen as abrasive,

Seen as sound, conforming, safe, and dependable.	creating dissonance?
Liable to make goals of means.	Seen as unsound, impractical; often shocks his opposite.
Seems imperious to boredom. Seems able to maintain high accuracy in long spells of detailed work.	In pursuit of goals treats accepted means with little regard.
Is an authority within given structure.	Capable of detailed routine (system maintenance) work for only short bursts. Quick to delegate routine tasks.
Challenges rules rarely; cautiously, when assured of strong support.	Tends to take control in unstructured situations.
Tends to high self-doubt. Reacts to criticism by closer outward conformity. Vulnerable to social pressure and authority; compliant.	Often challenges rules, has little respect for past custom.
Is essential to the functioning of the institution all the time, but occasionally needs to be "dug out" of his systems.	Appears to have low self-doubt when generating ideas, not needing consensus to maintain certitude in face of opposition.
When collaborating with innovators: supplies stability, order and continuity to the partnership.	In the institution is ideal in unscheduled crises, or better still to help to avoid them, if he can be controlled.
Sensitive to people, maintains group cohesion and cooperation.	When collaborating with adaptors: supplies the task orientations, the break with the past and accepted theory.
Provides a safe base for the innovator's riskier operations.	Insensitive to people, often threatens group cohesion and cooperation.
	Provides the dynamics to bring about periodic radical change, without which institutions tend to ossify.

Innovators and Adaptors in Organizations

6.6.2 Innovators and Adaptors in Organizations

Organizations in general and especially organizations which **are large in size and budget have a tendency to encourage bureaucracy and adaptation in order to minimize risk.** It has been, **said by Weber**, **and Parsons** that *the aims of a bureaucratic structure are precision, reliability and efficiency and that the bureaucratic structure exerts constant pressure on officials to be methodical, prudent and disciplined, and to attain an unusual degree of conformity.* These are the qualities that the adaptation-innovation theory attributes to the **'adaptor'** personality. For the marked adaptor, the longer an institutional practice has existed, the more he feels it can be taken for granted. So *when confronted by a problem, he does not see it as a stimulus to question or change the structure in which the problem is embedded, but seeks a solution within that structure, in ways already tried and understood-ways which are safe, sure and predictable.* He can be relied upon to carry out a thorough, disciplined search for

ways to eliminate problems by 'doing things better' with a minimum of risk and a maximum of continuity and stability. This behaviour contrasts strongly with that of the marked innovation. The latter's solution, because it is less understood, and its assumptions untested, appears more risky, less sound, involves more "Ripple-effect" changes in areas less obviously needing to be affected; in short, it brings about changes with outcomes that cannot be envisaged so precisely. This diminution of predictive certainty is unsettling and not to be undertaken lightly, if at all, by most people-but particularly by adaptors, who feel not only more loyal to consensus policy but less willing to jeopardize the integrity of the system, or even the institution. **The innovator in contrast to the adaptor** *is liable to be less concerned with the views of others, more abrasive in the presentation of his solution, and more at home in a turbulent environment.* He is liable to be seen as less oriented towards company needs (since his perception of what is needed may differ from that of the adaptors) and less concerned with the effect on other people of the methods by which he pursues his goals than adaptors find tolerable. Tolerance of the innovator is at its lowest end when adaptors feel pressure from the need for quick and radical change. Yet it is the innovators' least acceptable features which make them as necessary to healthy institutions as the adaptors' more easily recognized virtues make them necessary.

Relationships between Innovators and Adaptors

6.6.3 Relationships between Innovators and Adaptors

Problems of fruitful collaboration between innovators and adaptors are not infrequently based on the colored and often inaccurate perceptions which each group has of the other. Innovators tend to be seen by adaptors as abrasive, insensitive and disruptive, unaware of the havoc they are causing. Adaptors are seen by innovators on the other hand, as stuffy and unenterprising, wedded to systems, rules and norms of behavior which **(in the opinion of the innovators)** are restrictive and ineffectual. Consequently, disagreement and conflict are likely to arise when the more extreme types of innovator and adaptor come into working contact. Innovators are prone to overlook the extent to which the smooth running of any operation depends on a high degree of adaptiveness in the group but will be intensely aware of, and critical of the features of adaptiveness which limit long-term effectiveness: lack of enterprise, inflexibility of the system and preoccupation with detail.

It must be emphasized that **the agent for change may be either an innovator or an adaptor.** In a predominantly innovator group the agent of change will be an adaptor, and vice versa. This discovery overthrows traditional assumptions that heralding and initiating change is the prerogative of the type of person to whom the term innovator is now applied. A precipitating event may require either an innovative or an adaptive solution; whether it is generally expected or not depends on the original orientation of the group and the nature of

its task. An example in which an adaptor is an agent for change in a team of innovators is provided by the case, in which the precipitating event takes the form of a bank's refusal to extend credit as support to further new enterprise in a company that has cash flow problems. At this point the adaptor, who has been anticipating the event for months, is at hand with facts, figures and a contingency plan neatly worked out, and becomes a potential agent for change. This can be transformed into action if the change-agent has the personal qualities of competence, status and ability to influence others.

Creative Problem Solving Techniques

6.7 Creative Problem Solving Techniques

Problem solving is an integral part of organizational life. Every time a manager or leader directs people in producing a product or service, problems are being solved, decisions made. Every time any member of an organization thinks of a new way to reduce costs, invents a new product or service, or determines how to help the organization function better in some way, problem solving is taking place. But, whether the problem solving occurring in these situations is truly creative is another question, one that deserves a closer look.

For individuals, the development of creative problem-solving skills is a necessity, not a luxury. Because organizations too must solve problems, the development of these skills in their members is also a necessity. The most innovative individuals and organizations are the ones most likely to survive and prosper.

Creative Problem Solving: Higgin's Techniques

6.8 Creative Problem Solving: The Higgin's Technique

Not too many years ago, problem solving was defined largely as a **'rational effort'**. As scientists and management researchers tried to improve the problem-solving process, they focused on analysis and quantitative factors. But in recent years we have come to realize that a strictly rational approach misses the whole point of problem solving. Creativity is vital to successful problem solving. The problem-solving process therefore has come to be referred to as the creative Problem-solving, process or CPS.

According to James M. Higgins, there are **eight basic stages in the creative problem solving process:** *analyzing the environment, recognizing a problem, identifying the problem, making assumptions, generating alternatives, choosing among alternatives, implementing the chosen solution, and control*.

These stages are shown in **Figure 6.1**. The middle four of these stages are shown in the more detailed diagram presented in. This

figure provides more detail on these four stages primarily to show how the decision maker goes from problem identification and the selection of criteria to the actual choice of a decision. The following paragraphs briefly examine these stages from the practical viewpoint of problem solving within an organization. Personal, non-work-related problem solving would follow the same stages. Both analytical and creative processes are applicable to all eight stages.

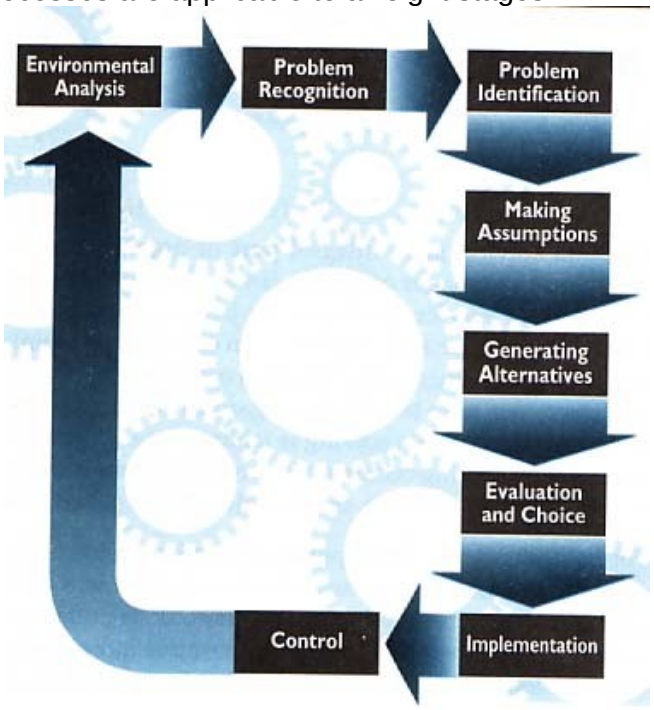


Figure 6.1: The creative problem-solving (CPS) Process.

Analyzing the Environment

6.8.1 Analyzing the Environment

If you're not constantly searching for problems ***(which, as defined here, include opportunities),*** *how will you know if they exist? And how can you solve problems or take advantage of opportunities if you don't know they exist?* Most strategists believe that firms must be prepared to respond quickly to problems and opportunities in order to be successful in the future. Thus, being able to recognize problems and opportunities as soon as they occur, or even before they occur, is vital to success. **Both internal and external organizational environments must be constantly and carefully monitored for signs of problems or opportunities.** In this stage of the process, you are gathering information. Information gained during the control stage of CPS is vital to this stage of the process. **Royal Dutch Shell Oil Company** spends millions of dollars annually tracking its competition and the economy, and learning about its customers, for just one type of information system the strategic information system. It also trains all levels of management to look for weak signals of environmental change. It spends thousands of man-hours creating forecasts /scenarios of possible futures, all to enable it to solve strategic and operational problems better. **The individual problem**

solver must also spend time and money searching the environment looking for signals of problems or opportunities. For example, spend a few minutes to look at your internal and external organization environments. What is happening that might lead to problems or opportunities?

Recognizing a Problem

6.8.2 Recognizing a Problem

You need to be aware that a problem or opportunity exists before you can solve it or take advantage of it. It is from the information gathered in analyzing the environment that you will learn that a problem or opportunity exists. Often, however, the problem solver has only a vague feeling that something is wrong or that an opportunity exists. **A gestation period** seems to occur in which information from the environment is processed subconsciously and the existence of a problem or opportunity eventually registers at the conscious level. For example, when Mikio Kitano, Toyota's production guru, began analyzing the firm's manufacturing cost information in the early 1990s, he intuitively sensed that something was wrong. The firm simply wasn't saving as much money, as it should from all of the automation and robotization that it had just completed. He believed **it was because robots were being used when human beings could do the job just as well, at less cost.** Other top managers doubted him, but in the end he proved that he was right saving Toyota millions of dollars in unnecessary investment.

Identifying the Problem

6.8.3 Identifying the Problem

The problem identification stage involves making sure the organization's efforts **will be directed toward solving the real problem rather than merely eliminating symptoms**. This stage also involves establishing the objectives of the problem-solving process and determining what will constitute evidence that the problem has been solved. The outcome of this stage is a set of decision criteria for evaluating various options.

Both rational and intuitive thinking may occur at this stage, but identification is largely a rational process. **Key questions to be asked include the following:**

1. *What happened or will happen?*
2. *Who does it or will it affect?*
3. *Where did it or will it have an impact?*
4. *When did it or will it happen?*
5. *How did it or will it occur?*
6. *Why did it or will it occur?*
7. *What could we do to be more successful?*

In asking these questions you are primarily interested in getting to the core problem or identifying the real opportunity.

Making Assumptions

6.8.4 Making Assumptions

It is necessary to **make assumptions about the condition of future factors** in the problem situation. For example, what will the state of the economy be when the new product is to be launched? Or, how will your manager react to a suggestion? Remember that assumptions may be a major constraint on the potential success of a solution, or may cause you to overestimate the potential of a particular alternative to solve the problem effectively.

Generating Alternatives

6.8.5 Generating Alternatives

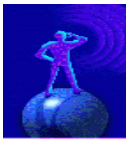
Generating alternatives involves **cataloging the known options** (a rational act) **and generating additional options** (a rational and intuitive act).

To the extent that you can **clearly identify and formulate useful options**, you can maximize the chances that a problem will be solved satisfactorily. The purpose of generating alternatives is to ensure that you reach the selection stage of CPS with enough potential solutions. Creative techniques for generating alternatives can help you develop many more possible solutions than you might come up with otherwise.

Generating alternatives is partly a rational and partly an intuitive exercise. It's rational in that you follow a series of steps. It's intuitive in that these steps are designed to unleash your intuitive powers so that you can use them effectively. In this stage, you should be more interested in the quantity of new ideas than in their quality. For most people, creativity reaches its highest levels in this stage of CPS. When Apple Computer Corporation's engineers designed the "Newton", the firm's new personal digital assistant computer ***(a small computer designed to help people in a wide range of jobs)***, they generated hundreds of alternative capabilities for the machine. In the end, several major ones were chosen over the others'.

6.8.6 Choosing Among Alternatives

Choosing Among Alternatives



Decision making should be **based on a systematic evaluation of the alternatives against the criteria established earlier**. A key, very rational part of this process involves determining the possible outcomes of the various alternatives. This information is vital in making a decision. The better the job done in generating alternatives and determining their possible outcomes, the greater the chance that an effective choice will be made. The choice process is mostly rational, but very skilled decision makers rely on intuition as well, especially for complex problems.

When Honda engineers pioneered the development of an engine that would get 55 miles per gallon, they had several alternatives to

choose from. Important to their decision of the technology they chose, were the impacts of the new technology on the costs of production, compatibility with existing transmissions, and so on. Each possible technology had to be evaluated for its impact on these factors. Similarly, McDonalds Corporation, in considering new menu items for its fast food restaurants, has hundreds to choose from. Each potential menu item has to be evaluated against important criteria such as freezability **(all McDonalds' ready-made foods are frozen)**, compatibility with other menu items, taste, customer demand, and cost/price relationships.

Kimberly-Clark's diaper division bet on Huggies Pull-Ups, he did so totally from intuition. The product looked promising but development proved difficult. He stayed with the product and eventually he was proven right. At the end of 1991, the product had 31% of the U.S. market.

6.8.7 Implementation

Implementation

Once you have a clear idea of what you want to do and a plan for accomplishing it, **you can take action**. Implementation requires persistent attention. This means accounting for details and anticipating and overcoming obstacles. Set specific goals and reasonable deadlines, and gain the support of others for your solution is a series of problems and opportunities.

When **General Mills Restaurants**, a subsidiary, of General Mills, Inc., began a total quality management program for its Olive-Garden chain, it paved the way for adaptation at all sites by providing a lengthy training and development program. In addition, success stories were chronicled and distributed on video tape to all restaurants.

Control

6.8.8 Control

Evaluating results is the final, and often overlooked, stage in the creative problem-solving process. The purpose of the evaluation is to determine the extent to which the actions you took have solved the problem. **This stage feeds directly into the environmental analysis stage,** which begins a new cycle of creative problem solving. It is important at this stage to be able to recognize deficiencies in your own solutions, if necessary. If you can admit to making mistakes or changing your mind without feeling defensive or embarrassed, you have acquired the skill of open-minded adaptation. This often requires objective thinking, intellectual courage, and self-confidence. At Federal Express, group decisions based on CPS are part of the everyday routine, and so is control. For example, when one team solved problems related to sorting packages, they were required to track results and make further improvements.

Group Techniques for Increasing Creativity

6.9 Group Techniques for Increasing Creativity

6.9.1 Brainstorming

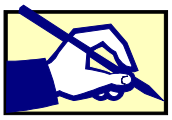
Brainstorming

The best known and probably most widely used procedure to **stimulate creativity is brainstorming**. It was originated in 1938 by **Alex F. Osborn** in response to his dissatisfaction with the-usual-business conference. **Osborn**, as did so many other business executives, came to regard the usual business conference as a waste of time because, although the business meeting would be called to deal with one or more important problems, it usually did not yield anything of value. Therefore, **Osborn** developed brainstorming as a means of achieving "organized ideation" in group meetings held in his advertising company. These group meetings began to be called *brainstorming sessions* because" 'brainstorming' means using the *brain* to *storm* a problem."

a) Theory

A) Theory

For Osborn "the creative problem-solving process" consists of: (1) **Fact finding, (2) Idea-finding, and (3) *Solution* -finding.**



Fact finding consists of two parts: problem definition and preparation. The former involves selecting and highlighting the problem while the latter involves assembling information related to the problem.

Idea finding involves producing ideas through idea generation and through the combination of and extrapolation from existing and available ideas.

The third phase of the creative problem-solving process, ***solution finding,*** involves evaluating ideas and adopting one of them for further development and eventual use.

Osborn recommended brainstorming for the second, **"idea finding,"** phase of the creative problem-solving process. **Brainstorming as we said is a method for coming up with ideas without regard to their evaluation.** This does not mean that evaluation is disregarded forever but rather that it is only deferred. Osborn carefully separated evaluation from idea generation for fear that evaluation, if it came too early, might adversely affect the number and quality of ideas produced in attempting to solve a problem.

This orientation in the brainstorming procedure, as Osborn himself points out, has a long history. A technique very similar to brainstorming has been used **by Hindu religious teachers for more than 400 years while working with religious groups**. The Indian name for this method is *Prai-Barshana. Prai* means 'outside you' and Barshana means 'question'. In such a session there is no discussion,

or criticism. Evaluation of ideas takes place at later meetings of the same group.

It is apparent then that Osborn believed that an individual could *deliberately* set out to come up with ideas that would provide creative solutions to problems; and what held for an individual also held for groups of individuals. He therefore recommended brainstorming to help overcome the restrictive and rigidifying effects of evaluation that occurred in most business conferences. On the group level, therefore, Osborn saw a brainstorming session as "nothing more than a creative conference for the sole purpose of producing a checklist of ideas; ideas which can serve as leads to problem-solution ideas which can *subsequently* be evaluated and further processed."

Efforts devoted to deliberately coming up with ideas for creative solutions could be facilitated by following two major principles and four major rules.

The two major principles are: *deferment of judgment and quantity breeds quality*. **The four major rules are:** (1) Criticism is ruled out; (2) freewheeling is welcomed; (3) quantity is wanted; and (4) combination and improvement are sought.

b) The Two Principles

B) The Two Principles

- **Deferment of Judgment**

Deferment of Judgment

Thinking, according to Osborn, involves both a **"judicial mind" and a "creative mind".** The former "analyzes, compares and chooses" (i.e., evaluates), whereas the latter "visualizes, foresees and generates ideas." The judicial mind "puts the brakes" on the creative mind - and these brakes need to be removed so that ideas can be generated. To remove these brakes, the first principle of *brainstorming - deferment of judgment-has* to be observed. The individual verbalizes or writes down his ideas without concern for their value, feasibility, or significance (all of which are, however, considered later). Yet he does not engage literally in free associations, for this might result in fruitless ideas: "instead of literally deferring judgment, we are, in reality, using 'limited-criteria' thinking-these 'limited' criteria being dependent on the way we state the problem." **For example,**

> In using the principle of deferred judgment, we don't say, "List ideas that come to your mind by free association. Instead, we say, "List ideas with respect to such-and-such a problem." When we list uses for a broom, for example, we are setting the criteria of "uses" and "broom" in our minds as we allow our automatic associative processes to go to work. In other words, we are saying, I will entertain any idea that comes to my mind with respect to using a broom in some way…." Hence I am judging (and ruling out)

> automatically any thought or idea that comes to my mind that is not pertinent to "uses of a broom" [Parries, 1967a, pp. 68-69].

Expressed differently, the problem as stated "sets" the individual, and his thought processes do not run on at random, but operate within the more limited framework of what Parnes calls primary criteria, for example**, "uses" and "broom"** in the sample just presented. What, then, is deferred? According to Parnes, secondary criteria are deferred. These secondary criteria include such evaluative thoughts as: Will it be too expensive; will it take too long to do; will it require too many people to do it?

Quantity Breeds Quality

- **Quantity Breeds Quality**

The second principle of brainstorming is that quantity breeds quality. The rationale for this dictum originates in associationistic psychology, which assumes that our thoughts or associations are structured hierarchically. **The most dominant thoughts** in this hierarchy are those which are most habitual, common, or usual, and are therefore likely to be, from other points of view, the "safest" and most acceptable to others. It is necessary to "get through" these conventional ideas if we are to arrive at original ones. After the dominant ideas have been reviewed and rejected, additional effort has to be expended in order to generate fresh associations. Implicit in this view is that somewhere in the repertoire of an individual's associations there are some that are original or others that, if combined properly, can yield creative results.

c) The Four Rules

C) The Four Rules

The two basic principles just described deferment of judgment and quantity breeds' quality, give rise to four essential rules for a brainstorming session.

Criticism is Ruled Out

1. **Criticism Is Ruled Out**: *All criticism and evaluation are put off until some future date.* This key rule is the means of implementing the principle of deferred judgment. It is so critical that when brainstorming is conducted in a group, some chairmen or leaders ring a bell whenever any member of the group criticizes another's ideas or is self-critical or apologetic for that which he has himself suggested.

Freewheeling Is Welcomed

2. **Freewheeling Is Welcomed**: Participants are to feel free to offer any idea; as a matter of fact, the wilder the idea the better, for "it is easier to tame down [an ideal than to think [it] up." The intent of this rule is to help the individual feel more relaxed and less inhibited than he might in ordinary circumstances by encouraging him to and implicitly rewarding him for using his imagination. It relieves him of responsibility for evaluation.

Quality is Wanted

3. **Quantity Is Wanted**: This rule is a restatement of the second principle of brainstorming, that the more ideas suggested the greater the probability that an original one will come up.

Combination and Improvement are sought

4. **Combination and Improvement are Sought**: The intent of this rule is to motivate participants to build on others' ideas by showing how already offered ideas might be improved or combined in various ways with other ideas. This rule not only encourages the development of additional ideas, but also offsets any feeling of embarrassment individuals might experience at not having been the first to think of an idea.

*To **summarize**, these two principles and four rules constitute brainstorming fundamental orientation to the generation of ideas irrespective of whether this orientation is practiced by an individual or by a group of individuals; to achieve a creative solution the idea-generation stage is separated from and is followed by idea-evaluation.* There are no specific guidelines on how to evaluate a list of ideas developed through brainstorming, probably because Osborn, brainstorming originator, assumed that people are more practised in idea evaluation than idea generation. Nevertheless, should an obstacle be encountered in the process of idea evaluation and should more ideas be needed, the brainstorming process following the two principles and four rules can be reinstituted.

d) Setting up for a group brainstorming session

D) Setting up for a group brainstorming session

Brainstorming with a group of individuals **is a bit more complicated than with a single individual not because of complications in the process but because of the number of persons involved.** A review of the literature highlights several important pointers regarding group composition, problem selection, etc. some points of which may also be of value to individuals using brainstorming.

e) Group Composition

E) Group Composition

Brainstorming, as we have said, involves a deliberate attempt to make effective use of what is known about the creative process. This holds true not only for the development of creative solutions to problems but also for the selection of people involved in the process. **To randomly select individuals to participate in** a brainstorming session and to expect them to come up with creative ideas is rather unrealistic. This is not to say that all possible participants do not have the potential for creativity, rather it is to highlight the point that maximization of the probability that brainstorming will prove valuable requires thoughtful selection of participants and leaders. We now turn to some of the more critical issues involved.

f) Participants

F) Participants

Participants **should have knowledge and/or experience with the field in which the problem is based.** If there are participants who have no previous experience with brainstorming then they should attend an orientation session at which they learn what to expect. This meeting could include a discussion of the fundamentals of thinking and forming ideas as well as the basic principles of brainstorming. Use can also be made of slides, movies, etc.

It is helpful for the group to include a few **"self-starters"** to get the ball rolling. If they dominate or monopolize the group it may be necessary to tell them to hold back. As Bristol put it, "In choosing your panel member, it is wise to choose at least one or two people of known creative ability. You may find it wise, also to choose a few panel members who are not too close to your problem, because their ideas may reflect a more refreshing approach to your problem".

Executives who *"have been over-trained in the usual kind of non-creative conference"* are undesirable as participants. All members of a brainstorming group should hold the same administrative rank within the organization so as not to feel inhibited in their superiors' presence.

Brainstorming groups can be established throughout an organization. Guests from other parts of the organization could be invited to any core group so that more and more people gain experience in solving problems creatively.

The optimal size of an idea-finding brainstorming group is twelve persons. The critical point is not so much the size of the group as that it should be an even number of persons. For idea evaluation or decision making, according to Osborn, one might want an odd number of participants. In the idea-finding group, in addition to the leader, associate leader, and recording secretary (who is not really a participating member of the group) the group can consist of five regular or core members and five positions that can be filled by nonregular members or visitors.

Obviously, both men and women can constitute a brainstorming group. And a group so composed can frequently add more rivalry, excitement, and zest to the group process.

g) leader

G) Leader

The group leader's personality, his knowledge and experience with the problem, and his knowledge and experience in brainstorming are all critical considerations in his selection. "You will want to choose him with great care, because your chairman can mean the success or failure of your brainstorming session. You want to choose a keen-witted, friendly person who is able to be both a 'driver' and a 'relaxers', that is, someone who can keep the session atmosphere friendly and informal".

The leader has to fulfil several very critical functions. He has to process the statement of the problem so that it is stated in a workable manner. He has to select participants who will be able to follow brainstorming's two principles and four rules. He has to prepare new participants. He has to provide a warm-up session for the group and

prepare the total group prior to the brainstorming session. And, he has to conduct the session in terms of brainstorming principles and in such a manner as to enable the group to manifest its full potentiality.

H) Associate Leader

h) Associate Leader

The associate leader **should have the same characteristics as the leader.** He helps the leader as necessary and should also be able to take over the leader's function should it become necessary to do so.

I) Recording Secretary

i) Recording Secretary

A secretary who is a non participating member of the group records participants' ideas and suggestions. **These may be recorded in a telegrammatic fashion but with enough data so that their general sense is not lost.** If the topic discussed is very technical then a secretary with technical knowledge has to be selected. On some occasions two secretaries have been used to keep up with the rapidity of the flow of ideas. On such occasions the secretaries take turns in recording every other suggested idea. Tape recorders may also be used but they need not replace the secretaries.

It is a good idea to **number ideas as they are recorded**. The leader then has a ready tabulation of the number of ideas produced which he can use to tell a group how well it has done and to spur it on to even greater production.

When ideas are recorded, **they are not noted with the name of the suggestor.** The need for group congeniality far outweighs the good of granting individual credit.

J) The Problem

j) The Problem

If brainstorming is to be effective it is necessary to state the problem properly. Brainstorming is not for all problems. According to **Osborn** it is indicated for problems that require idea finding rather than judgment. The problem to be selected is one that lends itself to many alternative possible solutions. Brainstorming cannot be of much help with a problem such as "when should we introduce such-and-such a new course"; But, it can be used to produce ideas for tests that would help in arriving at such a decision.

A problem should be specific rather than general. An example given by Osborn is that a general question may be that of introduction of a new synthetic fibre. To be more specific, it should be altered to ask what ideas would help to introduce the new fibre to weavers and mills or to introduce the new fibre to dress houses and cutters, etc.

***If a problem is a complex one,* it should be broken down into component subproblems** and each should be worked on separately. A brainstorming session may even be devoted to breaking down a problem into its subunits. And, then, a separate brainstorming session can be devoted to each unit.

k) The process

K) The Process

Prior to the brainstorming session, **the leader prepares about a 1-page memorandum in which the time and place of the brainstorming session is given as well as a very simple statement of the problem.** The memorandum also includes the background of the problem and examples of the kinds of ideas that are desired. If necessary, illustrations and other exhibits should accompany the memorandum.

This memorandum is circulated to the participants **at least 2 days before the brainstorming session** so that they can become acquainted with the problem and allows their ideas to incubate.

When the participants report at the time selected for the brainstorming session*,* the leader starts off new participants with a warm-up session using some very simple problem (improving men's pants is one suggested by Osborn) unrelated to the problem they will finally work on.

The leader presents the problem and answers questions. **The four brainstorming rules are stated:** *"(1) Criticism is ruled out. (2) 'Free-wheeling' is welcomed. (3) Quantity is wanted. (4) Combination and improvement are sought". Then he calls for ideas and suggestions from the group.*

Just as soon as a hand goes up the leader asks the person to state his idea. If too many hands go up, each person in turn is given a chance to state one idea. No one is allowed to read his ideas from a list if he brought such to the meeting. The lists can be given to the leader before the meeting and their contents should be given at the meeting.

As people verbalize their ideas, one idea may stimulate a related idea. These are called "hitch-hikes", and they are given priority of statement in the brainstorming process. It is important that a participant have some way of signifying (e.g., snapping his fingers) that he has a hitch-hike so he can be given priority by the leader. A participant might well make a note of his ideas so that he doesn't forget them.

When the group seems as if it is running dry, the leader might encourage the participants to come up with more ideas by telling them how well they have already done or by urging them to come up with "about 10 more ideas," etc. He can suggest his own ideas during these slow periods or come up with idea.

We could have something that you placed over a cup and as you pressed it, it opened out to release some sugar and at the same time spun to stir the sugar in.

... If there is so much fun stirring in sugar then perhaps we ought to have some sort of inert sugar which people who don't like sugar could use in order to enjoy stirring in.

A once off spoon made of sugar.

A device which contains sugar and which is moved up and down in the cup. But if you don't want sugar you keep a gate closed.

. . . I would like to take up the idea of electricity but not using a battery or anything like but using the static electricity present in the body.

... This idea of a screw. One could do it on the autogiro principle. As the screw went up and down the fluid would make it revolve.

... Like a spinning top.

... A vibrating table that would agitate everything on it-whether you had sugar or not.

... What about a sugar impregnated stick?

At the end of the brainstorming session participants are asked to keep the problem in mind for the next day allowing them further opportunity for incubation. They are later contacted by the leader who notes their new ideas if they have come up with any. A list of all ideas is then compiled and after the leader ascertains that ideas are stated succinctly and clearly, and properly classified if necessary, is presented to the evaluation group.

L) Evaluation Group

l) Evaluation Group

In brainstorming, **idea generation is separated from idea evaluation.** Therefore after the ideas are compiled they are presented to an evaluation group consisting of five persons. There is an odd number in an evaluation group to avoid ties in arriving at decisions. A brainstorming group, it will be recalled, consisted of an even number but such a group was not involved in decision-making or evaluation activities.

Osborn tells us that an evaluation group can be constituted in various ways. It can consist of all of the members of the previous (idea-generation) panel, some members and some non-members of the idea-generation panel, or it might be made up of a completely different group of people.

Whenever this group is constructed it should be composed of individuals who will have direct future responsibility for the problem. As an aid in deciding the relative merits of the various ideas, the evaluation group may use a checklist of criteria. They might ask themselves whether the idea is simple, timely, costly, spurring

questions as: What other uses can one make of such-and-such? How can such-and-such be changed in terms of colour, sound, and motion? etc.

As ideas are suggested they are noted by the secretary. **Experience has shown that 30 minutes is an optimal period for a brainstorming session.** However, some practitioners suggest 15 minutes or less and some as much as 45 minutes.

m) Brainstorming in Action

M) Brainstorming in Action

The following is an excerpt of an idea-generating brainstorming session quoted from **De Bono's** book, *Lateral thinking: Creativity Step by Step.* It was to redesign a teaspoon.

… A rubber spoon

… I feel that the secondary function of a spoon which is that of transferring sugar from the basin to the cup has largely disappeared and that a teaspoon in the shape of an egg whisk would be much more efficient.

... (Put down egg-whisk.)

... And make it electrically driven.

... Incorporate a musical box for the aesthetic function.

... Have something like a pipette tube which you dip in the sugar with your finger over the top and transfer sugar in that way. Then the sugar would be provided with a dispersing agent so that you would entirely lose the pleasure of stirring.

... Going back to the egg whisk 1 think one ought to have a sort of screw thing, rather like an electrical swizzle stick. The axle would be hollow...

... (Can I interrupt here? You are beginning to tell us how you would make it and that are not the function of this session.)

... No, I am just describing what it looks like.

... (Could you describe it more simply?)

... A rotating spoon?

... No it's got a screw. You know a propeller type screw. ... You push it up and down?

... No it's electric; you just press the button on the top.

… It seems to me this is too complicated. Now you have an ordinary sugar tongs and each individual would have his own sugar tongs and would pick up a couple of lumps of sugar. The tongs have two ends and you could create turbulence just as easily as with a spoon.

... Doesn't this restrict you to lump sugar?

… Yes, small lumps. But you can still get the quantity of sugar you want.

... (What shall we put down there?)

... Tongs.

... What about something like those ashtrays which spin as you press them?

… Feasible, etc.

Those ideas that are selected are reported back to the idea generation group so members of that group can still maintain a sense of participation in arriving at a creative solution to the problem.

It will also very likely be necessary to persuade others in the organization to accept an idea or a tentative working model of an idea. This may require knowledge and experience in marshalling arguments and being persuasive. Finally appropriate techniques need to be used in introducing the final work to the audience at large.
At each step in the total process there may be the need for additional new ideas. Under such circumstances, a brainstorming session and the process, as described previously, can be begun again.

n) Errors and pitfalls to Be Avoided

N) Errors and Pitfalls to Be Avoided

There are certain mistakes that should be avoided, if the effects of brainstorming are to be maximized. Bristol suggests the following:

1. **Failing to get support for your brainstorming program** of at least one of your superiors.
2. **Boasting prematurely about brainstorming** and getting your colleagues to expect too much.
3. **Failing to indoctrinate** your panel adequately.
4. **Submitting the unscreened** list of ideas to people unfamiliar with how brainstorming works. It is best to keep the unscreened list confidential.
5. **Failing to see that** the next steps are taken.

Osborn also suggests as two reasons why brainstorming may not work: the failure to follow instructions *(by the group leader as well as the participants)* and exaggerated expectations. What can be expected is that some sessions may produce final answers, provided the problem has been stated simply enough; some sessions may

produce planks for plans; some sessions may produce checklists that are guides to stimulate further thinking; some sessions may produce approaches to subsequent solutions.

O) Its Uses

o) Its Use

To avoid unrealizable expectations it is necessary to recall Osborn's assessment of brainstorming as "only one of the phases of idea-finding which, in turn, is only one of the phases of the creative problem-solving process". **He adds:**

"Let's bear in mind that group brainstorming is meant to be used - not as a substitute - but as a supplement, and especially in these three ways:

1. **As a supplement to individual ideation***:* Individual effort is an indispensable factor in creative problem solving. Brainstorming sessions should never be considered as a substitute for such effort. Group brainstorming serves solely as a supplemental source - a means of generating a maximum number of potentially usable ideas in a minimum of time.
2. **As a supplement to conventional conferences:** The usual conference is necessarily judicial, both in spirit and in function, and therefore relatively unproductive of ideas. This does not mean that brainstorming sessions should supplant conventional conferences. It merely means that conventional conferences can be profitably supplemented by an occasional brainstorming session - if and when creative thinking is the primary purpose.
3. **As a supplement to creative training***:* In over 1,000 courses in creative thinking, group brainstorming has been used as one of the teaching methods. This type of self-demonstration does much to induce a more creative attitude and to develop fluency of ideas. By the same token, participation in brainstorming sessions can help improve the average person's creative ability, not only in group effort, but also in individual effort.

By way of emphasizing the nature of the relative contributions of both individual and group brainstorming, it should be noted that **Osborn** said, "Despite the many virtues of group brainstorming, individual ideation is usually more usable and can be just as productive. **In fact,** *the ideal methodology for idea finding is a triple attack:* (1) Individual ideation. (2) Group brainstorming. (3) Individual ideation".

This then is a summary of the theory and assumptions underlying brainstorming, the factors to be considered in setting up a brainstorming session, and the factors to keep in mind to maximize the benefits to be reaped from its proper use. Needless to say, many more details may be obtained from reading **Osborn's and Parnes'** basic works.

Synectics

6.9.2 Synectics

Synectics, **"the joining together of different and apparently irrelevant elements",** originated with **Gordon**. It is based on the use of metaphors and analogies within a systematic framework to achieve creative results. It is central to synectics that we can attain better comprehension of a problem that is strange or unfamiliar to us by thinking of an analogy or metaphor that makes it more familiar and hence more amenable to a creative solution. On the other hand, there are problems with which we have difficulty because we are too familiar with them. We feel we are "too close" to them. We cannot see the forest for the trees. Under these circumstances, once again an appropriate metaphor or analogy provides us with necessary distance so that we can get a better view of the problem and move on to a creative solution.

In synectics, then, the problem as one is presented with it initially, has to be restated and looked at in various ways through the use of metaphors or analogies. During the course of this process, the individual goes on what synectics people call an ***"excursion"*** and as a result of such a trip creative solutions are attained. Just how different kinds of analogies and metaphors may be used, what the purpose and function of an excursion is and related matters are all part of synectics training.

Synectics began about 1944 when **Gordon** undertook an intensive study of individual and group processes in creativity. This was followed with systematic exploration of his ideas in 1948 with a group of artists in what Gordon refers to as the Rock Pool Experiment. Gordon later formed a subgroup within the consulting firm of Arthur D. Little & Co., and went on to set up synectics groups in several companies. He left Arthur D. Little in 1960, and together with G. M. Prince, whom he had met there in 1958, set up Synectics, Inc. in Cambridge, Massachusetts, to provide training facilities and training personnel for those interested in learning his technique to stimulate creativity. He then left Synectics, Inc. to start another organization, Synectics Education Systems (SES), which "is involved with all forms of problem-solving and education based on the metaphorical approach". Synectics Education Systems works both with groups and individuals. It is not limited to groups “because such learning experience makes people group-bound and unable to function alone".

Gordon's views of the creative process and how to stimulate it are set forth in his first book, *Synectics (**Gordon, 1961**).* This book contains the basic information on what Gordon called psychological states and the operational mechanisms, both of which will be discussed at greater length. Synectics also contains descriptions of how synectics has been used systematically in various situations, as well as Gordon's thoughts on how a synectics group might be set up within an industrial organization. Gordon's later book, The

Metaphorical Way, is devoted to the central concept in his system-the metaphor. He discusses its use in education, learning, the inventive process, and psychological processes. The *Metaphorical Way* also contains an interesting section on the variations in the use of the metaphor in synectics in which Gordon also brings synectics up to date from his point of view. Gordon's primary involvement, therefore, is with what he calls the operational mechanisms-what we would regard as the mental procedures and techniques for unlocking the psychological processes involved in creativity.

Although Prince also makes use of metaphor in his work, his major interest is in how group processes can be used to stimulate more creative contributions.

A) Metaphors

a) Metaphors

Awareness of the importance of nonrational processes and the attempt to engage them through the purposeful use of metaphors probably reflects the uniqueness of the synectics approach. Many individuals have theorized about the roles of the preconscious and unconscious in the creative process, but no one has so systematically tried to engage these sources of creative possibilities as have the synectics people. However, rational and logical processes are also used in synectics. They too are valued, encouraged, and enhanced in a group atmosphere that is free, easy-going, and accepting. *Furthermore*, regardless of the emphasis placed on nonrational factors, the whole synectics process occurs within a framework that has very practical goals.

There are many factors that shaped the processes used in synectics. **Gordon's and Prince's** reading, thinking, and theorizing, as well as their observations of the problem-solving behaviour of the groups with which they worked were no doubt very important considerations. Gordon cites several instances from pure and applied sciences where he believes metaphorical thinking played a critical role. Commenting about his own thought processes, Einstein is said to have reported that he used visual and muscular **"signs"** and **"images".** The Wright brothers based their work on turning and stabilizing the airplane on observations of buzzards keeping their balance in flight. **James Clerk Maxwell** is said to have used balls and cylinders in working out his 'electromagnetic wave theory. Darwin's work was based on several earlier developments; one was Lyell's demonstration of the earth's age and his refutation of the notion of catastrophic extinction of animals. Lamarck described evolutionary continuity. What Darwin lacked for his theory was how animal adaptations occurred. Gordon reports that Darwin based his work on the efforts of husbandrymen who could selectively breed animals to make them more valuable. Thus, he developed the thesis that there was a naturally occurring selection process among wild animals similar to that used by husbandry men with domesticated animals.

Laplace is also mentioned by Gordon for his use of the self-healing process of the body in the development of his theory that the status of the solar system is continually restored despite derangements that are radical and temporary.

Schrodinger talked about living organisms sucking in negative entropy when eating and breathing, for his critique of the second law of thermodynamics. Brunel developed the concept of the caisson on the basis of observations of the boring capacity of the toredo, a shipworm.

Bell used the function of the inner ear bones as one of the bases on which he built the telephone receiver; and Kektule, imagining a snake swallowing its tail, thought of carbon atoms in a ring rather than in a linear chain. Pasteur used the analogy of "safe attack" for his work on hydrophobia, and Cajal the analogy of “protoplasmic kiss" for his work on the manner in which nerves transmit impulses.

b) Theory and Techniques of Synectics

B) Theory and Techniques of Synectics

- **Psychological States**

Psychological States

Among the various factors that play important roles in the theory and technique underlying synectics are **four "oscillating" psychological states involved in the creative process** and one other state that is not so oscillating-the hedonic response. These states are induced by several operational mechanisms to be discussed later.

The four psychological states are:

Involvement and Detachment

(1) ***Involvement and Detachment*** -This state refers to the relationship between the individual and the problem on which he is working. Involvement refers to understanding and interacting with the elements of the problem. In involvement, there is a feeling for and resonance with the problem. However, the creative process also involves the capacity to detach from and become distant from the problem-to view it objectively.

Deferment

(2) ***Deferment*** -There is a danger in quick and immediate solutions to a problem: Experience has shown they are likely to be premature and superficial. Deferment refers to the capacity of both the individual and the group to defer these quick solutions until they have arrived at the best one.

Speculation

(3) ***Speculation*** -The group and its individual members need to be able to let their minds run free so that they can come up with ideas, hypotheses, and solutions. Speculation refers to this type of thinking.

Autonomy of Object

(4) ***Autonomy of Object*** - As the creative process proceeds and a solution is approached, there is a feeling that the solution has an entity and demand quality of its own. The individual or group must be willing and free enough to allow this feeling to develop and to follow it.

Hedonic Response

(5) ***Hedonic Response*** - Synectics involves, among other factors; play with “apparent irrelevancies". This play is used to generate energy for problem solving and to evoke new views of problems. One of these irrelevancies is an emotional factor called "hedonic response", which serves as an "irrelevance filter". The feeling involved in the hedonic response is very subtle. It is similar to the inspiration or intuition that is sensed prior to achieving the solution to a problem. It is the pleasurable sensation that accompanies the feeling of being fight about a hypothesis or a solution before it has been proven correct. There are both aesthetic and pleasurable elements in hedonic response. Gordon has been unable to develop an operational mechanism to bring it about. It is obviously of tremendous importance, and if an individual could learn how to recognize it, then he would probably not waste so much time and energy in the creative process; the individual would have that "feeling" - aesthetic or otherwise - that would "tell” him when to follow up a hypothesis and when to pursue a tentative idea to solution. Most techniques for stimulating creativity have one or more procedures for stimulating ideas and possibilities that may result in manifest creativity. None of them has much to say about how to go about selecting from what one has thought of. The fiedonic response may be a clue to what might be helpful in this regard. To learn more about it and enable us to make better use of this response, Gordon suggests that tape recordings of synectics sessions be reviewed and that special attention be paid to those points at which an individual achieved a breakthrough in the problem-solving process. Such study may lead to knowledge of those cues that alert an individual to the fact that he is coming upon something quite significant. It is important that this point be recognized because, once a solution is articulated, it becomes autonomous and develops a life a *"being"* of its own.

Operational Mechanisms

C) Operational Mechanisms

The aforementioned psychological states are induced by operational mechanisms. ***There are four such mechanisms:*** (1) personal analogy; (2) direct analogy or example, (3) symbolic analogy or book title or essential paradox or compressed conflict; (4) fantasy analogy. When working on a problem what one actually utilizes are these operational mechanisms, and if they operate effectively, then the psychological states function very quietly and take care of themselves. The operational mechanisms do not make up the whole problem solving process, but they are a most important part of it.

One of the functions of the operational mechanisms is to make the familiar strange. In so doing, one of the important psychological functions that are accomplished is to increase the "distance" between

the individual and the problem. This increased distance enables the individual to avoid becoming stuck with what he already knows about a problem and being limited to it. As we shall see, the degree of distance achieved between individual and problem varies as a function of the operational mechanisms used. The four operational mechanisms are:

a. Personal Analogy

a. Personal Analogy

The individual imagines himself to be the object with which he is working. He *"becomes"* the spring in the apparatus and feels its tension, or he *"becomes"* the pane of glass and allows himself to "feel like the molecules in it as they push and pull against each other. The rigid and controlled individual finds this hard to do, for it stirs too much anxiety and insecurity. To use this mechanism effectively involves the capacity to *"lose"* oneself.

As a result of his work with this mechanism, Gordon believes that the critical element in personal analogy is empathic identification and not mere role playing. Role playing as a means of arriving at personal analogy is rather useless when working on a problem with a sociological or psychological base-a people problem. For this kind of problem, role playing, instead of making the familiar strange, makes the strange familiar because it does come up with enough strangeness.

Together with compressed conflict this operational mechanism is regarded as an auxiliary operational mechanism [direct analogy is the basic operational mechanism]. A personal analogy has more freedom and breadth than does a direct analogy, and the former yields more understanding than the latter.

Four degrees of involvement in *personal analogy* have been described. They are as follows:

(1) **First-person description of facts.** This is very shallow and involves a mere statement or listing of facts. Thus, in the Synectics Teacher's Manual the example is given of someone who is asked to imagine he is a fiddler crab and he says that he would have a hard outside and a soft inside, etc.

(2) ***First-person description of emotions*.** This level represents "the lowest order of identification". The content of this analogy, although better than the previous form is too general to yield any very valuable insight about that which the analogy was developed. For example, when asked to imagine himself as a fiddler crab, a person responded that he was busily involved in getting food for himself and had to watch out that he did not become food for a bigger fish. Such an analogy yields no added insight into the fiddler crab since all animals are confronted with the problem of eating or being eaten.

(3) ***Empathic identification with a living thing*.** This is regarded as "true" personal analogy. It represents both kinestlietic and

emotional involvement with die object. Again, while imagining to be a fiddler crab, a person might say that his big claw is rather burdensome and useless. When he waves it nobody is frightened and it is quite heavy to carry around.

(4) ***Empathic identification with a nonliving object*.** This is the most sophisticated kind of empathy. Relatively speaking, it may be easy to attribute human emotions to living objects as in level (3) but it is much more difficult to do so with nonliving objects. For example, when asked to imagine that he was the mud in which the fiddler crab lives, a person said that he felt that no one cared about him. The crabs do not thank him and he would like to make them do so.

Prince describes only three levels of involvement in personal analogy-the first two are the same as the first two just described, and the third combines the third and fourth just described. Prince feels that the use of personal analogy can help a group become more cohesive. After members of a group have produced good personal analogies, Prince feels they can work together more effectively.

b) Direct Analogy or Example

b. Direct Analogy or Example

Here facts, knowledge, or technology from one field are used in another *(e.g., a shipworm runneling into wood serves as an analogy to solve problems in underwater construction).* Biology, Gordon believes, is one of the most fruitful areas for direct analogies in solving technical problems. Knowing how certain goals and activities are accomplished in biological organisms serves as a good basis for developing ideas in technology and other areas. Emphasis on biology does not preclude interest in other areas. Whatever other information an individual has at his disposal may be helpful to him in direct analogy.

Experience has shown Gordon that organic direct analogies used for inorganic problems, or inorganic direct analogies used for organic problems, are more effective than organic for organic or inorganic for inorganic.

Gordon makes an intriguing statement about the relationship between *"constructive strain"* that is introduced *"by the distance on the analogy" and the "level of inventive elegance".* He says that analogies with small psychological distance from the problem can be effective for problems being worked on for the first time; but for problems that have been worked on a great deal, analogies that reflect great psychological distance-those that are rather remote from the individual's experience-are required.

Prince says that the more strange the example *(his term for the direct analogy),* the greater the logical distance between subject and example. And the less the seeming relevance to the example, the greater is the chance that it will be meaningful and helpful in the

problem-solving process. He points out that two examples of closure are door and mental block. The latter is more likely to enable an individual to look at a problem in a new way than is the former because it is logically more distant from the subject and it is less immediately relevant.

Direct analogy is the basic mechanism by which an individual tries to see problems in new contexts. A direct analogy is clear and straight forward. It produces immediate results and "its process can be reproduced".

c. Symbolic Analogy, also Called Book Title, Essential Paradox and Compressed Conflict

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This form of analogy uses objective and impersonal images to describe the problem. An individual effectively uses symbolic analogy in terms of poetic response; he summons up an image which, though technologically inaccurate, is aesthetically satisfying. It is a compressed description of the function or elements of the problem as he views it *(e.g., one synectics group used the Indian rope trick as a basis for developing a new jacking mechanism).*

Although direct analogy is the basic operational technique, compressed conflict and personal analogy are used together with it to increase the conceptual distance between the individual and the problem. In a compressed conflict there is direct analogy with built-in *"conceptual strain"*; there is both a modifier and a noun; the noun reflects the direct analogy and the modifier produces strain or conflict, e.g., *'structured freedom'* "or" *'wax cloud'.*

Prince, in whose system book title bears many similarities to symbolic analogy and compressed conflict, says that in a book title there is *"both an essence of and a paradox involved in a particular set of feelings".* The function of book title is to generalize about some specific matter and to use the generalization to suggest a direct analogy. According to Prince, the technique helps people who stay close to the problem to get away from it.

Prince cites a group working on a problem involving a ratchet and, when asked to develop something paradoxical, contradictory, or opposed to one of the ratchet's characteristics dependability, the group came up with dependable intermittency, directed permissiveness, and permissive one-wayness.

d. Fantasy Analogy

d. Fantasy Analogy

This is based on Freud's idea that creative work represents wish fulfilment. The individual states a problem in terms of how he wishes the world would be. For example, the synectics group that was working on a vapour proof closure for space suits asked the question, *"How do we in our wildest fantasies desire the closure to operate?"* This form of analogy is said to be very effective if used early in the process of making the familiar strange. Gordon regards it as an

excellent bridge between problem stating and problem solving because it also tends to evoke the use of the other mechanisms.

In the early days of synectics, it had become apparent that fantasy analogy was getting mixed up with the other mechanisms. It seemed to be part of the other mechanisms. Between 1961 and 1965 it was not used because it did not seem necessary. Fantasy analogies were usually offered by group members while they were using the other analogies. Synectics sessions in which fantasy analogy is used become productive very quickly but can also become dry very quickly. It is a very efficient operational mechanism but also a very limited one according to Gordon's experience.

Synectics thus tries, in the course of problem solving situations, to make the familiar strange and to make the strange familiar through the use of the different types of analogies just described. These analogies enable the individual to look at problems in new ways, and thereby hopefully gain new insight into the problems.

Also by means of the operational mechanisms, synectics attempts to make conscious what goes on in the unconscious. It is also through the use of the operational mechanisms that the psychological states of involvement, detachment, deferment, speculation, and commonplaceness are induced. These states create the psychological climate necessary for creative activity. It is assumed that all people have experienced and utilized these analogies. Hence, when group members are asked to use them in synectics sessions, they do not feel they are being manipulated. They claim that their natural creative potential is increased rather than decreased.

It is apparent from the descriptions of the operational mechanisms that they are simple. However, it does take a great deal of energy to apply and use them. Synectics, therefore, does not make creative work easier but "rather is a technique by which people can work harder". At the end of a synectics session, participants may emerge quite fatigued, because they move into areas that appear irrelevant and expend a good deal of mental energy developing their analogies and trying to determine how well those analogies help to solve the problem. Although sometimes exhausting, the synecties session is often profitable and mentally fulfilling.

The material presented on psychological states and operational mechanisms contains much of the required theory for understanding the basics of synectics. For these basics to be of use in creative problem solving more is required than what has been said thus far. Before considering the characteristics of the problem-solving process or how a synectics session is conducted, let us look at the characteristics of its constituent members-the leader, the participants, and the client-expert.

d) The Participants in a Synectics Meeting

D) The Participants in a Synectics Meeting

In addition to their experience in coming up with new ideas and the time they have spent analyzing the creative process in groups, synecties workers have also had much experience in the conduct of group meetings and have learned 'how to utilize group dynamics so as to facilitate the creative process.

The *"typical" (i.e., nonsynectics)* meeting, Prince points out, reflects confusion in purpose or confusion in organization. While the function of meetings is generally described as solving problems, people participating in them usually find their creativity and speculations discouraged. An antagonistic attitude toward ideas is evident, and group leaders use their power unwisely. Group leaders usually feel more important than group members and hence there is not much open and free communication in the group.

Prince sees **a meeting as consisting of offering information, asking for information, and accepting or rejecting information.** He believes that in the traditional meeting, each person sees the situation as capable of being won or lost. For Prince, group participants manifest combinations of such opposing characteristics as sensitivity and aggression. Sensitivity dictates that the individual takes advantage of opportunities and manifests his creativity. However, when responding in terms of aggression the individual displays poor conduct. Thus, such an individual may put forth a creative idea in an aggressive way. This may elicit aggressive criticism and the individual must spend a good deal of time defending his ideas and/or repairing his image. Therefore, the sensitive-aggressive individual appears to be constantly on the defensive. Prince tries to counteract such negative aspects of behaviour in groups. He believes that the information involved in a negative situation can be conveyed to an individual without evaluation or rejection, and that everyone in a group does have a contribution to make and no one needs to lose or to feel he is losing something.

Prince has developed a variety of methods, some of which he admits are "mechanistic", to help keep a group at a high level of effectiveness. One of those developed to cope with negative features in a group is called the *spectrum policy*.

At a meeting there is a spectrum of ideas or suggestions. All of the ideas may be good or parts of the ideas offered are good and acceptable and other parts are unacceptable. Prince believes that people tend to emphasize the unacceptable characteristics. In doing so, however, they impede the development of solutions. In the early stages of problem solving, no member of the group can tell whether or not an idea or any part of it may indeed prove quite valuable at some time during the problem-solving process. Consequently, it is unwise to concentrate on the bad characteristics. Group members should build on what is worthwhile, and try to overcome the faults in

an idea. One of the problems that people have in applying the spectrum policy is that they simply do not listen to each other. Prince solves this problem by suggesting that if someone cannot find something good in what another has said, he should keep the other person talking until he can apply the spectrum policy-comment on what he does not like but also comment on what is good in the idea.

Another technique that Prince uses effectively involves videotaping the group's sessions. The tapes are played back to the group so that the participants can observe and discuss their own, each other's, and the total group's interaction.

The other important factor that Prince emphasizes is a clear perception of the roles that all persons - *the leader, the participants and the client-expert* - play in the group sessions. In a traditional meeting, these roles can be commingled, but in synectics they are separated and clarified to avoid confusion. The role prescriptions will be spelled out on the following pages, but as a general overview in a single, concise statement, it can be said that for Prince (1970a) the leader is servant of the group, the group is servant of the problem, and the client-expert is the problem's representative. The client-expert's opinions are honoured solely with respect to the problem and not with regard to the conduct of the group or its behaviour. Let us now turn to what Prince has to say about each of the roles.

e) Leader's Role and Principles of Leadership

E) Leader's Role and Principles of Leadership

It is important that the leader structure his role according to the following principles:

1. **"*Never Go into Competition with Your Team*":** This is a very difficult principle for leaders to accept, since everyone feels he has ideas to offer. However, it is important that this principle be accepted, since leaders are likely to favour their own suggestions. If this were to happen participants would become discouraged and not participate fully in the meeting.

There are times when the leader can contribute his ideas in a synectics group-when early possible solutions are sought (suggestions) and during a stage called *force fit*. Even on these occasions the leader offers his only when no others are offered. Should someone else have an idea, it has precedence over the leaders. The leader supports members' ideas and if possible he should build or add to a member's idea to strengthen it.

2. **"*Be a 200 Percent Listener to Your Team Members*":** The leader's job is to understand participants' points of view. He should be sure he understands a participant's point of view, and to achieve this goal he might well try to paraphrase what he hears. He should *not* evaluate what he hears. In this manner, the leader fosters an

atmosphere in which everyone's idea is worthy of consideration. In his books Prince presents a list of phrases to be used by leaders for "intervening without manipulation" and to generate nondefensiveness.

3. **"*Do Not Permit Anyone to Be Put on the Defensive*":** The leader operates with the belief that there is value in whatever a participant offers, and his job is to find that value. The leader never asks for justification of a metaphor; he accepts opposing points of view, and if a member starts by looking for negatives he asks him to tell what he likes about what he heard *(spectrum policy);* when an idea looks like it may falter he tries to keep it alive by generalizing from it; he sees to it that ideas are never completely condemned, they are only put aside; he sees to it that no participant is pinned down, pressured, or put on the defensive.

Laughter should be looked into because it may be stirred by an elegant idea that is just beginning to emerge and no one may be consciously aware that this is so.

4. **"*Weep the Energy Level High*":** The leader's intensity, interest, and alertness can spread through the group. It is therefore of help for him to move around and underscore points by using body movements. He should select areas of interest to himself, and keep the meeting moving quickly; he should be humorous or encourage humour in others; he should ask challenging questions; and use the element of surprise.

5. **"*Use Every Member of Your Team*":** All group participants are to be used and encouraged to respond. Quiet and/or shy persons may need to be brought out or handled quite tactfully. Prince suggests that verbose members be thanked rather quickly after a response; their eyes should be avoided when the leader asks for a response; and the leader should hold his hand up and look at someone else to stop the compulsive talker.
If none of these techniques works, a frank talk or the suggestion that the compulsive talker listen to the tape of the session may be worthwhile.

6. ***"Do Not Manipulate Your Team"*:** The purpose of the group is to come up with new solutions. A group is generally manipulated if the leader already has a solution in mind and his goal is to get the group to accept it. The leader's authority and responsibility is to aim the members' minds in a specific direction". He keeps them informed as to where they are in the synectics process, but he does not push for a specific solution.

7. ***"Keep Your Eye on the Expert"*:** The final goal of a meeting is to provide the expert with as many potential solutions or "viewpoints" as possible. It is therefore very important that the leader keep his eyes on the expert. When the expert seems to be interested in something,

the leader keeps going at it and works with the group to come up with more viewpoints, and if the expert gets very involved with a possible solution the leader should even encourage him to take over. When an expert responds to something, the leader should be careful to note that the spectrum policy is followed. Positive statements, what the expert likes about something, should be included with negative ones.

8. **"*Keep in Mind that You Are Not Permanent*": ** Assuming that traditional leaders can enjoy too much the exercise of power and authority, and also assuming that everyone wants to be a leader, Prince suggests that the leadership role be rotated. Thus, everyone can be motivated to participate more fully. If one can be both participant and leader he can learn the relative advantages and disadvantages of either role.

In summary, then while Prince regards the leader in the traditional meeting as "self-serving and manipulative", he sees the leader in the synectics meeting as serving others. The leader must use his power and capacity to control a group very carefully, for he becomes a model for the group members for the time when they will become leaders, as well as affecting their behavior directly when he is leader. The leader watches, records, and stays with a plan as the group moves freely and imaginatively along. He emphasizes imagination and flexibility and tests all kinds of ideas for their usefulness. He maintains a constructive viewpoint constantly by keeping open communication lines between participants, he does not allow fear of being wrong to be a deterrent to participation, and he tries to see to it that experts' objections are also used constructively.

The leader gives priority to avoiding damage to anyone's image; to directing aggression against the problem and not the people; and to showing that through effective participation no one loses and everybody wins.

f) The Participant's Role

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The participant's role is to give all of himself to the problem. In so doing, he will manifest his uniqueness and individuality, and thus every participant in a group ends up looking at a problem in his own way. The participant uses his own sensitivity to offer ideas and speculations about the problem at hand. He need not concern himself with whether or not a suggestion or idea is helpful. In this sense, synectics also removes evaluation as one of the participants' responsibilities. The participant should try to overcome his habitual tendency to spot weaknesses in ideas and try to expose them. It is better if he seeks ways to overcome the weaknesses he spots. In the process of being a participant the individual also learns about leadership patterns by observing his leader, and he can profit from this as well as from his own reactions to these patterns since he too will have to assume the leadership role at some point.

g) Client-Expert's Role

G) Client-Expert's Role

The third role in a group is that of the expert. He is the individual with the most factual understanding of the problem. He is generally the client's representative and within the client's organization is the person who is responsible for solving the problem. Consequently, in most traditional meetings the expert is likely to be put on the defensive. Having the responsibility for solving a problem, he may not relish the idea of having someone else solve it. For effective participation in a synectics group he must strive to overcome this attitude. He must become both participant and expert. By freely speculating about ideas during the course of a meeting he sets an example for the participants to follow. In his responses to participants' ideas and suggestions he follows the spectrum policy in which he tries to strengthen the positive in their ideas and point out weaknesses. In this fashion he encourages the group to build on that which is positive. In so doing, his intent is not to be polite but rather to be thorough. His is a difficult role since he supports ideas, but he must also be realistic and voice realistic concern as he moves along.

The expert tries to demonstrate to the group that he is there to find workable ideas. *He is not to build himself up at others' expense.* He points out acceptable directions. He shows the group he is willing to listen to their ideas. He builds on their suggestions when possible, and he helps the group understand as much as necessary about the problem. He counts on the group, since he is the one who will most likely make use of potential solutions.

The leader checks the goals that the group is working toward with the expert. The leader also checks with the expert to make sure that possible solutions and viewpoints are clearly understood.

A synectics group is never larger than seven individuals; it is better to have six than seven and ideal to have only five. The group includes the leader, the client-expert and the participants. If the group is run within a company, **Lee of Remington Arms**, who has used synectics in his company, recommends that some of the group represent the department directly involved in the problem and the remainder come from different departments. One should try to ensure a "good mix" and bring together different personalities. Leek suggests that the men's boss should not be the group leader, and if possible he should be kept out of the group.

The group's meeting place is important. It needs to be quiet and have no distractions. It is therefore important to protect the group from interruptions by secretaries, telephones, etc. Leek held his meetings close to nature, in a fishing club in the woods and a stable of an old mansion owned by his company. He has also held meetings in a local theatre club, a motel room, and home basement.

As indicated previously, meetings should be taped, and the tapes

should be available to the group members for review of their processes and behaviour. A synectics session requires the expenditure of a fair amount of energy; it is recommended, therefore, that no session go longer than an hour without a break.

h) Synectics Problem-Solving Process

H) Synectics Problem-Solving Process

We have covered the psychological states, the operational mechanisms, the various individuals who make up a synectics group, and the roles they play. These constitute almost all the basic ingredients for a synectics problem-solving session and almost all the critical jargon and terminology. There are still several other terms, such as *problem as given, purge, suggestion, force fitting,* and *viewpoint.* All of these and several others will be noted in their proper places, defined, and discussed as we present the synectics problem-solving process. Again, **Gordon's and Prince's** approaches will be combined, and where differences exist they will be pointed out.

The synectics problem-solving process consists of three major segments. **The first** is devoted to defining, elaborating, analyzing, and understanding the problem. **The second** is devoted to applying the different operational mechanisms, the metaphors and analogies, to the problem. When this is completed the group tries to *force a fit* between what they have arrived at as a result of applying the operational mechanisms and the problem on which the group was working. Hopefully, the result of the force fit is such that it either is a solution to the problem, a suggestion that, can lead to a solution, or an idea that results in a better understanding or better approach to the problem. Under the last circumstance, the whole process is now begun again bearing in mind the new view of the problem. The process may be repeated as many times as necessary until a solution is found.

Because a synectics session can become quite free flowing, discipline and structure have been introduced by the synectics people by way of a flow chart. The place of the group in terms of the flow chart may be written on a blackboard or on a flip-chart placed on an easel by the leader so that the members of the group will know where in the process they are. The material that follows will be presented in the form of a flow chart.

1. Problem as Given (PAG)

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For both **Gordon and Prince**, the character of this step is denoted in its title. The problem may be posed by an outside source or by an individual in the group.

Prince adds an interesting emphasis. He suggests that the word *"problem"* may connote, for some individuals, obstacles or difficulties which might serve to block an individual in his efforts. **Prince** recommends substituting for the word problem the word opportunity, which can serve as a positive signal for solving the problem.

2. Short Analysis of the PAG

2. Short Analysis of the PAG

Essentially these first two steps constitute attempts at analyzing and defining the problem. The first step is a statement of the problem as presented by the client. Another technique has also been used by Gordon. In this procedure the problem or goal is actually hidden from the group and in its place the group is asked to discuss a matter central to the goal. **For example,** in one problem the group was to come up with a new can opener. It was not told, however, that the goal was a can opener. Actually, problem-solving activity began with a discussion of what *"opening"* meant to the group.

Whatever approach is used for the group's activity, the first two steps in the process are to *"make the strange familiar",* as Gordon puts it. The group tries to understand the problem and to make still unrevealed elements in the problem better known. One of the dangers of this phase of the problem-solving task is to become too engrossed in details.

Prince puts **greater emphasis on the client-expert and at this point in the process** calls on him to present an analysis of the problem in sufficient detail that everyone has a good understanding of it. Of course, no one need have as complete an understanding as the expert.

An example of what transpires thus far in the process comes from Prince's book in which the problem as given, is to "*Devise an ice tray that releases ice without effort*". The expert starts by explaining the problem in sufficient detail that the group has a common understanding. Since the expert is also a participant, he does not need to reveal all the minute details of the problem. These can all come out later during the session. **For example,** in the ice tray problem, the expert's contribution consisted of the following statement: "The ice tray must be superior to anything on the market and must not cost any more than those already available".

3. Purge; Immediate Suggestions

3. Purge; Immediate Suggestions

During the time that the group is clarifying the problem it is likely that individuals will think of suggestions or solutions. Such solutions are not likely to be valuable; they should *however,* be verbalized. By doing so, individuals and the group can rid themselves of superficial ideas and are forced to turn to more innovative possibilities. Solutions at this point of the process serve another function. It will be recalled that the expert also participates in the problem-solving process. Therefore, early solutions can be criticized by the expert, resulting in further clarification of the problem as a by-product.

4. Problem as Understood (PAU); Goals as Understood (GAU)

4. Problem as Understood (PAU); Goals as Understood (GAU)

Some element or aspect of the problem as given is selected for work and solution. This element is called the *problem as understood.* It is stated as clearly as possible, and members of the group focus on it.

Prince suggests that, at this step, **each participant be called upon to come up with his personal way of seeing the problem and his dream or wishful solution.** These are written down by the leader. *Prince feels that engaging in such personal ways of looking at the problem at this point is important for the following reasons:* (1) Each participant can make the problem his own. He can preserve his own individuality and need not be forced into a shared consensus. (2) Giving each person an opportunity to state the problem as he sees it takes advantage of the diversity in the group. (3) Allowing oneself to engage in wishful thinking at this point enables the participant to broaden his perspective and not restrict himself to limiting conditions. (4) By analyzing the goals as understood, the goals can be broken down into parts of problems that can be dealt with separately, thereby eliminating the need to cope with a large, unmanageable problem.

Continuing with the ice tray problem, **the following two goals as understood were arrived at:** "1. how can we make an ice tray disappear after ice is made? 2. How can we teach an ice tray to release instantly on signal"? *(The last goal is not as wishful or as far-fetched as it may appear, for if an ice tray is suspended it will make icicles which when they reach a certain size can be used to signal the release.)*

After checking with the expert, the leader selects one of the goals as understood to work on. He then asks the group to put the problem out of its mind and to concentrate on what he asks. Essentially, he now starts to take the group on a mental excursion.

5. Excursion

5. Excursion

At this point, a rather extended stage of the problem-solving process follows, which for Prince, is **like taking an "artificial vacation" or "a holiday from the problem".** He makes a point of asking the participants to put the problem out of their minds. He is aware that if they are capable of doing so, they will put it out of their conscious minds while continuing to work on it in their preconscious minds.

It is during this stage of the process that the different operational mechanisms - *the different kinds of analogies* - are used. Essentially, it is during the excursion that the group tries to "make the familiar strange". The leader questions the members and tries to evoke responses to his requests for different kinds of analogies.

Prince adds further elaboration of this step. He suggests that after analogies are produced that the leader selects one of them for further *examination. The example is selected on the basis of these criteria:* (1) The leader finds it interesting. (2) The example seems strange and irrelevant to the problem. (3) He thinks the group has some information about the example or analogy.

The example is examined to produce **"*factual and associatory material*"** which enables the participants to view the problem in a new way. The facts produced during an examination are differentiated by Prince as "*simple descriptive facts*" and "*super facts*", which are more speculative and "more associatory". These are more interesting and useful than descriptive facts.

Prince points out that a good deal of self-discipline is involved in the examination since the participant must not think back to the problem unless he is asked to do so by the leader. Thus, each step in the excursion closes the door on the previous step. In so doing, Prince believes that the probability of diversity in thinking is increased.

Thus, both Gordon and Prince conclude the excursion in essentially the same way. In Gordon's terms the direct analogy is analyzed for further understanding, and for Prince the example is examined.

i) Setting up a Synectics Group Within an Organization

I) Setting up a Synectics Group within an Organization

It is possible to establish a synectics group within any company, and Gordon and Leek have done so. In his book, Gordon presents several specific ideas on the selection, training, and reintegration of a group chosen for synectics training and whose goal would be product improvement and product development within a company. These suggestions are probably not very workable in most situations. They are presented here only to stimulate further thinking about various possibilities on the part of individuals who might want such a group within their own organization. The purpose of "stimulation only" needs to be emphasized, since several groups that have been established in various companies have not survived. The reasons for this fact are neither all clear nor all available. It may well be, for example, that being involved in synectics is not a full-time job. But whatever the reasons, what follows might be of help to those who want to start such groups.

J) Selection of Participants

J) Selection of Participants

Eight criteria for selecting participants for an in-house synectics group are suggested by Gordon.

(1) **Representation-**the group, consisting of five to seven members, should be representative of the company's total operation.

(2) **Energy Level-**a group member should have a high energy level.

(3) **Age**-members should be over 25 and under 40 to maximize the probability of selecting flexible individuals and individuals with experience. These age limits also allow for more homogeneity in salary levels and status.

(4) **Administrative Potential-**individuals with administrative potential have the ability to generalize, and furthermore, since these individuals are likely to rise in the organization, starting with them increases the probability that synectics techniques

will later be introduced at higher levels of management.

(5) **Entrepreneurship -** the group must be able to accept the responsibility for the success and failure of its operation regardless of management's sanction. The group should feel apart from the company since if it is too close to it, it may feel and/or actually be controlled by the company.

(6) **Job Background** - diversity in experience allows for a broad base of knowledge of the company.

(7) **Education -** the selectee should have a history of having shifted major fields of interest. Broad interests will help increase his "metaphoric potential."

(8) **The "Almost" Individual -** experience has shown that there are individuals who have characteristics of productive people but whose own work remains mediocre. These persons may have their abilities "liberated" by a synectics program.

Each potential participant then goes through further selection in meetings with the "Synectors", members of Gordon's staff, to determine if he possesses the following characteristics: metaphoric capacity, attitude of assistance,. kinesthetic coordination, enjoyment of risks and what kinds of risks, emotional maturity, capacity to generalize, commitment, nonstatus orientation, and "complementary aspect". Of course, each person in the group cannot be expected to have all desirable characteristics to an equal degree. Deficiencies in one person should therefore be compensated for by characteristics of the others, and the last characteristic mentioned, complementary aspect, refers to whether a person's characteristics complement those of others in the group and whether theirs complement his.

The group, as finally composed, thus represents a wide variety of skills, knowledge, and interests. One of the most important criteria in selecting group members is their "*emotional constitution*" - the way in which they go about solving problems. For example, is the individual amused at himself when he is wrong, does he use his energy effectively or does he become passive at crucial moments? The synectics group should be composed of individuals with a variety of emotional constitutions. Thus, if there were a choice between two individuals of similar intellectual background and emotional orientation, only one should be chosen; but two individuals with the same intellectual backgrounds and different emotional orientations might both be included. Emotional and experiential diversity helps the group tolerate different approaches to a problem with depth.

Since no group of five to seven people can have all the technical competence to determine the technical feasibility of a solution, experts can be called in as needed. The expert either plays the role of encyclopaedia or devil's advocate. He is a resource person who provides technical advice or isolates weakness in a concept or solution.

The leader of the group, the person who will become the group's administrative head when the group is reintegrated into the company, is to be selected on the basis of observations made of the group during the course of his training. He needs:

(1) **Extreme optimism** - reflected in believing that anything is possible;
(2) **Total grasp** - involving experience in life and in industry that would enable him to integrate and interpret what comes up in the group;
(3) **Synectics grasp** - a deep understanding of synectics; and
(4) **Psychical distance** - a capacity to maintain proper control over his personal involvement with others so that sessions can be steered constructively.

k) Course of Training

K) Course of Training

The selected group, **Gordon** suggests, should have a place in the company that is separate from others so that high morale can be built. It undergoes training for 1 week a month for 12 months. Training begins with having the members read books that are selected to help them increase their metaphoric potential. These are books in the life sciences, because they yield the best metaphors, and "*books of trauma*" - for example, those which describe polar expeditions, exploration in general, and disasters at sea. The books serve to increase bonds between group members and to alert them to many basic life situations for which creative ideas and inventions are necessary. There are discussions with the group as to how their industry fits into the National and Global economy and how they fit into their company's value system.

With this as groundwork, the group selects one of the problems presented to it by the company for solution - trainers help it apply synectic mechanisms either by demonstrating the mechanisms or by replaying tape recordings of the sessions to correct the errors that the group may have made and to alert them to appropriate uses.

Throughout the year the group is in training, each of the individual members tries to develop an understanding of the work activities of the other members. In this manner, the group becomes better integrated. The group is also made to feel it must move faster than similar groups in existing traditional large corporations.

There are certain reactions that need to be guarded against during the early experiences of the group. One is the feeling of guilt. Although the group works hard and long, its members may nevertheless be vulnerable to guilt feelings. Members may find the work not onerous but enjoyable. Selectees also suppose that they are expected to conform to certain roles; it takes them time to learn that they are expected to behave as they wish. Finally, during the early days of training, selectees are cynical until there is some successful experience.

Gradually, the trainers become less and less important to the success of the group, until finally the group works independently of them. Independent sessions, however, are tape recorded for later evaluation by the trainers. Since the group works on company problems, management is in a position to pace and during the training program, rate the quality and quantity of the group's accomplishments.

References

References

1. Ainsword-Land, G. (1986). Grow or Die. The Unifying Principles of Transformation. N.Y.: John Wiley & Sons.
2. De Bono, E (1969). The Mechanism of Mind. Penquin Books: Harmondsworth.
3. Dworetzky, J. (1985). N.Y.: West Publishing company, 212-218.
4. Fobes, R. (1999). The Creative Problem Solver's. A complete Course in the Art of Creating Solutions to Problem of Any Kind Portland: Solution Through Innovation, 10-12.
5. Glover, et al., (1990). Cognitive Psychology for Teachers N.Y.: MacMillan publishing company.
6. Gilhoy, K.J. (1982). Thinking Directed, Undirected and Creative. N.Y.: Academic Press., 1-2.
7. Hitt, W. (1988). The Leader Manager. Guidelines for Action. Richland: Battle Press.
8. Huffman, K. et al., (1994). Psychology in Action. N.Y.: John Wiley & Sons, 111-113.
9. Isksen, S. (1987). Frontiers of Creativity, Beyond the Basics. N.Y.: Bearly Limited 1-26.
10. Khalaf, F. (2002). Systems and Creative Thinking (Ed.). Cairo: Cairo University, Petroleum Engineering Department.
11. Kirton, M. (1987). Adaptors and Innovators: Cognitive Style and personality: In: Isaksen, Ed. (1987). Adaptors and Innovators, 282-304.
12. Metallinas, TN (1996). Television Aesthetics, perceptual, cognitive, and compositional bases. N.J. Lawrence Erlbaum Associates, 91-95.
13. Parteaus,D. (1989). Environmental Aesthetics. Lodnon: Rautledge, 28.
14. Russ, S. (1993). Affect and Creativity. Condon: Lawrence Erlaum Associates, Publishers, 3-6.
15. Stein, M. (1975). Stimulating Creativity, Vol. 2 Group procedures. N.Y.: Academic press. 25-70.
16. Shallcrass, D. (1985). Teaching Creative Behavior. N.Y.: Bearly Limited, 55-59.
17. Stein, M. (1974). Stimulating Creativity. Vol. 1 Individual Procedures. N.Y.: Academic Press. 58-60.
18. Staw, B. (1991). Psychological Dimensions of Organizational Behavior. N.Y.: Macmillan Publishing Company, 295-297.
19. Sternber, R. & Petterman, D. (1986). What is Intelligence? N.J.: Ablex publishing corporation, 60-61.
20. Sternberg, R. ed. (1988). The Nature of Creativity. N.Y.: Cambridge Univ. Press, 125-147.

21. Taylor, C. (1988). Various Approaches to the Definitions of Creativity. In R. Sternberg. (Ed.) The Nature of Creativity, Ibid.
22. Totman, R. (1985). Social and Biological Roles of Language. N.Y.: Academic Press., 85-86.
23. VanGundy, A. (1987). Organization Creativity and Innovation In: Isaksen, Ed. Op. cit., 358-379.
24. West, M. & Farr, J. (1990). Innovation and Creativity at Works Psychological and Organizational Strategies. N.Y.: John Wiley & Sons. 265-267.
25. White field, P.R. (1975). Psychology in Industry. Penguin Books: Harmonsworth, 34-36.

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