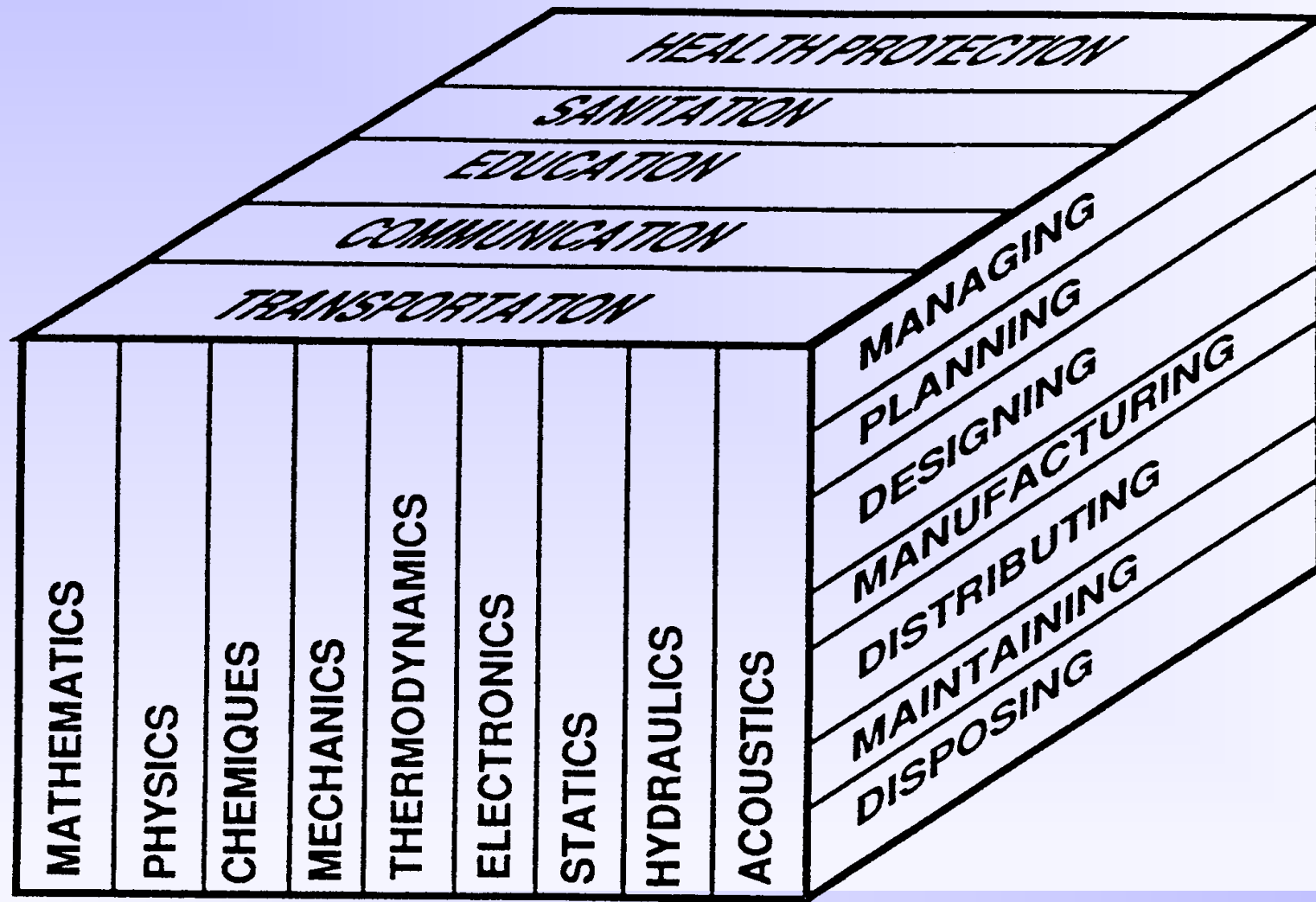
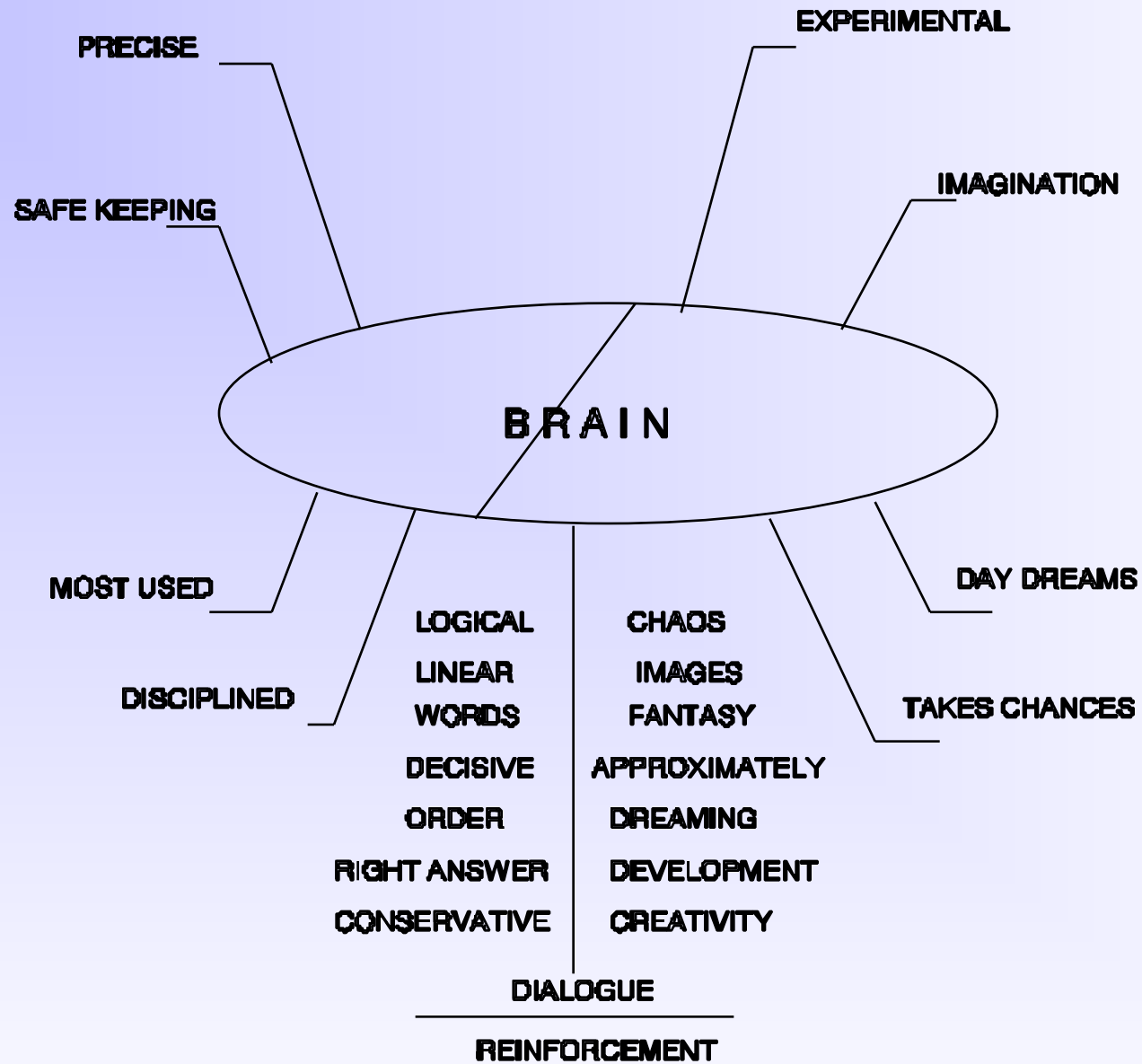


Three Facets of an Engineering Career



SPLIT BRAIN THEORY

- Psychologists have shown that the left hemisphere of the brain (in right handed persons) tends to concentrate verbal and symbolic logical reasoning, while the right hemisphere (in right handed persons) tends to concentrate spatial and holistic reasoning. Unfortunately, educational processes have become dominated by the left brain learning. It is quicker, easier, and more measurable than right brain learning; it fits closer to learning objectives. Advanced degrees tend to select students most successful at left brain operations, and these students subsequently become the educators. A transformation that should be facilitated in the education of any modern engineering student involves a shift from the singular dependence upon the left brain with its emphasis on the equation for the right answer to also include the nonlinear, right brain with its ability for holistic analysis and synthesis.
- From Williamson and Hudspeth, Teaching Holistic Thought Through Engineering Design, Oregon University, Corvallis, Oregon.



TEAM IDEATION

- Ideal for concept definition and large/difficult design problems.
- Brainstorming
- Programmed Invention
- Idea Trigger Session
- Synectics
- Lists As Simulators
- Morphological Approach

BRAINSTORMING

- Alex F Osborne developed the technique of deferred judgment, or brainstorming, as a way to increase the individual's synthesis capabilities by releasing the human mind from the analysis mode of thinking . Brainstorming is considered to be a group method of gathering ideas pertaining to the solution of a problem. In some cases the method is used to identify local problems in need of solution.
- The technique of brainstorming takes place in a panel format. The brainstorming panel is composed of a leader, recorder, and panel members. The leader is responsible for maintaining a rapid flow of ideas while the recorder lists the ideas as they are presented. Panel size can vary, but a size of twelve is considered to be optimum.
- The average brainstorming session is most effective when it is approximately 30 minute long.

OSBORNE RULES FOR BRAINSTORMING

- Criticism Is Ruled Out :
- Judgment of ideas is deferred until a later screening or evaluation period. Be positive.
- Free Wheeling Is Welcomed. :
- The wilder the ideas, the better. Offbeat, impractical suggestions may trigger in other members practical solutions which might not otherwise occur to them.
- Quantity Is Encouraged :
- The greater the number of ideas, the greater the likelihood of winners. It is easier to eliminate ideas than to add new ideas to the list.
 - Combinations and Improvements Are Sought :
 - Panel members are encouraged to suggest how ideas by others can be turned into better ideas, or how two or more ideas can be combined into a better idea.

THE BRAINSTORMING SESSION

■ Preliminary Notice :

- It is helpful if participants are given at least one day's notice of the brainstorming session and its objectives. This preliminary notice permits participants to do some individual idea generation, and each participant can be more efficient at the session with clear objectives in mind.

■ Introduction :

- The team leader should review the brainstorming rules and the objectives of the session. The recorder should be located close to the team leader for convenience.

■ Ideation :

- The team leader will open the brainstorming session by calling for spontaneous ideas from the panel. The participants will hold up their hands for recognition by the leader, and will respond as briefly and as rapidly as possible. The leader will immediately recognize the next panel member. All ideas will be listed by the recorder. No negative ideas or criticism will be given; flow of ideas should be spontaneous.

■ Hitchhiking :

- A person who would like to develop or add to someone's idea should hold up his or her hand and snap his / her fingers for priority recognition by the leader. A series of hitchhiking ideas will permit a rapid evolution of ideas that could improve the basic concept.

■ Stimulation :

- The team leader should stimulate the session when ideas lag by introducing related areas for discussion. A short five minute recess may prove helpful. The ideation process must be rapid and spontaneous.

■ Close :

- The leader will adjourn the session when the available ideas have been reasonably exploited.

■ Review And Evaluation :

- The recorder should provide a list of ideas to the panel members for further study and analysis. Approximately 100 ideas should come from an average class of 30 students in a 30 minute period. Only at this point should the ideas be analyzed for their merits. Care should be exercised in studying these ideas lest a possibility be overlooked. A further session could be held to develop specific ideas after detailed study.

- Alex F. Osborne, Applied Imagination. Charles Scribner's Sons. 1963.

PROGRAMMED INVENTION

- One of the major disadvantages of brainstorming technique is the possibility that someone will get credit for another person's ideas. For example, suppose person A comes up with an original idea that person B builds on. Let's say that B's improved idea is recognized as something special and is praised by the panel members. Member A's original thought is lost in the discussion and no credit is given to A. A will probably remain silent during the remainder of the session with the attitude, "I'll be damned if I will help out this group.". Unfortunately this is the nature of brainstorming and its main drawback.
- Programmed Invention (PI) attempts to correct this obvious defect. The PI session is conducted much like the brainstorming session, in which the ideas are wanted in quantity with "blue sky" thinking encouraged. The PI session differs in one important step. When a member of the group suggests an original thought (say member A), all idea generation stops upon a signal from the team leader, and every member focuses on A's idea to make it better, extend it, or build on it. During this discussion A records all pertinent constructive extensions of the idea on index cards (7 * 9) and signs and dates them. In this way the group truly works to the benefit of the individual and he/she get full credit for the original thought.

IDEA TRIGGER SESSION

- The Idea Trigger Session is a group technique for generating as many ideas as possible for solving a specific problem. A team leader runs the session and leads the team through two phases; the Silent Phase or Purge, and the Spoken Phase or Trigger. Each member of the team maintains a record sheet which is composed of several long vertical columns on each page. Keywords are to be recorded to describe each new idea.

■ Silent Phase Or Purge :

- In this phase the individual members of the team write down ideas as rapidly as possible in the first column. Since tension, or relaxation, or alternatively applied pressure and relief, have been found to enhance creativity, two minutes are given by the team leader to the individuals to write down as many ideas (keywords) as possible. At the end of the two minute session the team is given several minutes of relaxation. After the relaxation break, the team is given 30 seconds to complete the first column.
- "Blue Sky" ideas are encouraged since they may trigger useful ideas, later in the Spoken Phase. Ideas must be expressed keeping in mind that the subject at hand is the result of a disequilibrium between the actual customer behavior pattern, his expectations, and the current technological answer. At the end of the Silent Phase the participants have purged themselves of all the ideas that came to mind.

■ Spoken Phase Or Trigger :

- In this orderly phase, and for each trigger exclusion, each participant, one at a time, clockwise, describes rapidly his/her ideas. The others on the team silently cross from their list duplicate ideas they may have in the first column, and add new ones continuously in the second column as they are triggered by the ideas of the speakers.
- After the first exclusion, a second one follows counter clockwise, using second column ideas, while new ideas are written in the third column. Second and third column ideas are the most important since they were probably not present at the onset in the deep recess of the participants memory tracks, or they could not have been formulated by associations or analogies due to lack of foreign input. The ideas of the second and third columns are mostly the result of trigger phenomenon because :
 - Either one is miffed, that is, negatively reinforced for being duplicated and moves in a new direction.
 - Or one is negatively reinforced by competitive pressure, willing to do better (upmanship) or differently (originally) than others just heard.

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- Or one is positively reinforced by a substantial list of one's own not yet duplicated ideas and is adding more.
 - Few new ideas are generally left for a fourth column and the team is generally mentally exhausted.
 - A small student group may take one hour for the first time exclusion; 30 minutes after training.
 - On difficult problems, the purge phase will average 8 minutes, and the trigger phase may last 4 hours.
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- George H. Muller, The Idea Trigger Session Primer, A.I.R. Foundation, Ann Arbor, Michigan, 1973

SYNECTICS

- The Synectic Method of group idea generation was invented by William J. J. Gordon around 1960. Synectics is a Greek word meaning the fitting together of seemingly diverse elements. The technique uses metamorphical and analogous information exchanges within a carefully selected group of individuals of varying personalities and areas of specialization, with the team leader playing a dominant role during the discussion.
- The problem is first explained to the team (leader, five to ten members, a recorder) in detail and is repeated until all understand it thoroughly. The leader then begins the selection by choosing the method of attack, such as role playing, an investigation of certain minute details of the problem, or presentation of an analogous situation which may or may not have a direct bearing on the problem. When an interesting idea of possible significance is suggested by someone in the group, the leader attempts to steer the discussion into an elaboration of, and sometimes an analysis of, the idea.

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- The synectic technique might be used, for example, in designing space tools, more specifically, designing a device for an astronaut to use when drilling a hole in an orbiting platform. The leader will review the problem relating to such a device; need for portable power supply; lubrication at extremely low temperatures; zero reaction force devices; storage of the tool. The leader may then decide to select the analogy approach of making the strange familiar by suspending a piece of styrofoam from a length of thread attached to the ceiling and attempting to drill a hole through it with an electric drill without steadying the styrofoam with his free hand. As expected, the styrofoam will sway as the drill force is applied and the hole cannot be drilled. A live and sometimes dramatic demonstration can be strongly motivating to the observer.
 - At this point, the team will be instructed to suggest methods of producing the hole in the styrofoam, and sooner or later someone will suggest burning it with a cigarette. The leader will then lead the group to focus in on this idea with an attempt to force fit the solution to achieve the same objectives in space.
 - In general, the synectic technique is based on the fact that the mind is more productive when dealing with a new or foreign environment. The analogous situation takes one away from the exact problem at hand and requires the individual to consider a related program. This has a tendency to make the strange familiar, or in another situation when appropriate, the familiar strange.

■ EXAMPLES

- If a team were considering a novel snow removal system, the team might consider how soil is filled, or how leaves are disposed of.
- When considering the design of an office building, the team might consider how a beehive is constructed.
- Trees might be studied when dealing with structural shapes.
- Novel methods of mowing a lawn takes the form of detailed analysis on the process of cutting and tearing.

■ ANALOGIES

- Personal analogy
- Direct analogy
- Fantasy analogy
- Symbolic analogy

- William J. J. Gordon, Synectics, Harper and Row, 1961.

LISTS AS STIMULATORS

- A simple way for an individual to develop a number of ideas in the shortest time is to make lists. Lists can be used in several modes of operation to stimulate the user to think of new ways to accomplish the goal at hand.
- Checklists :
 - The checklists method proposes that the user make a general list of questions to apply to the problem at hand. Some of the questions may apply to all problems encountered, but some questions must be generated specifically for the current problem. A typical list of question might include :
 - In what ways can the idea be improved in quality, performance and appearance ?
 - To what other uses can the idea be put ?
 - Can it be modified, enlarged, or minified ?
 - Can some other idea be substituted ?
 - etc.

■ Attribute Listing:

- Attribute listing is a technique that is most valuable in improving tangible items, such as products. This technique is based on the assumption that most ideas are extensions or combinations of previously recognized observations. Attribute listing requires the following :
 - Listing the key elements or parts of a product.
 - Listing the main features, qualities, or significant attributes of the product and of each of its key elements or parts.
 - Systematically modifying, changing, or eliminating each feature, quality, or attribute so that the original purpose is better satisfied, or perhaps a new need is fulfilled.

■ Trigger Words:

- Trigger words can be used as stimulators to develop means for accomplishing an intended purpose or action. Key words are identified to describe the actions to be achieved in the design. For each of these key words, the individual lists as many words that describe actions which can be used to achieve the intended purpose.

■ Summary:

- Lists are merely stimulators and are not intended to replace original thinking. However, list techniques can be used to extend the power and effectiveness of the mind during the ideation process.

IDEATION TECHNIQUES

- The Checklist Technique
 - Put to other uses ?
 - Adapt? like-copy-suggest
 - Modify ? change-color-order-shape
 - Magnify ? bigger-longer-extra-add
 - Minify ? subtract-lower-shrink-cut off
 - Substitute ? replace-other-what else
 - Rearrange ? scramble-alter sequence
 - Reverse ? opposite-backward-invert
 - Combine ? blend-add to hook up with
- The Attribute Seeking Technique
 - Devise a new Lawn Mower
 - Attributes :
 - Grass blade cutting
 - Propulsion over lawn surface
 - Operator control
 - Power supply
 - Trimmings disposal

"TRIGGER WORD" SAMPLES

- MOVE
 - Float-push-roll slide
 - Shove-lift-drag-slip
 - Leap-run-fly-pull
- GET OPEN
 - Melt-peel-cut-tear
 - Slice-screw-whirl-roll
 - Explode-blend-unravel
- PUT IN
 - Squirt-drop-pour-fall
 - Tilt-fold-ram-knock
 - Construct-dump-swing
- GET SHUT
 - Blend-wrap-weld-clip
 - Bolt-roll-solder-lock
 - Nail-pin-press-mold