THE CONCEPTS OF CREATIVITY AND THEIR STIMULATION IN PROFESSIONAL PERSONNEL

by

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Signature of Author..................................................
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Certified by..................................................
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May 13, 1955

Professor L. F. Hamilton  
Secretary of the Faculty  
Massachusetts Institute of Technology  
Cambridge 39, Massachusetts

Dear Professor Hamilton:

In accordance with the requirements for graduation I herewith submit a thesis entitled "The Concepts of Creativity and Their Stimulation in Professional Personnel."

I would like to express my appreciation to Dr. I. F. Kinnard and Dr. A. Hansen of the General Electric Measurements Laboratory for their views concerning the management of creative people. I am also deeply indebted to Professor John Arnold, thesis advisor and Professor Douglas McGregor, thesis committee member, for their advice and cooperation during the preparation of the study.

Sincerely yours,

Raymond A. Pittman
The Concepts of Creativity and Their Stimulation in Professional Personnel
by
Raymond A. Pittman

Submitted to the School of Industrial Management on April 25, 1955, in partial fulfillment of the requirements for the degree of Master of Science.

The key to survival for any business enterprise may well depend on the creativity of its people.

The thesis study attempts to derive the concepts of creativity and consider their various means of stimulation in professional employees staffing the facilities of our modern research laboratories.

In the first part of the thesis study, the factors of talent, effort, age, knowledge, and education are considered with respect to creative efficacy.

In the second part of the study the creative process is discussed from the "organized" and "inspired" approaches.

In the third portion of the thesis, the role of the professional employee in the laboratories of our modern business enterprise is identified, and various means of stimulating creativity in the professional are suggested.

In conclusion, the practical application of stimuli to creativity in professional personnel is outlined using the Engineering Research Department of the Ford Motor Company as an example.

Thesis Advisor: John Arnold
Professor of Mechanical Engineering

Committee Member: Douglas McGregor
Professor of Management
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Introduction

Creativity in our population can be our greatest national asset.

The highest form of imagination is the creative, and its functions are mainly two-fold - the first, to pursue or seek diligently - the second, to alter or change. In this manner one does more than discover unknown but existent truths - he invents. He brings together things or thoughts not new in themselves and places them together in a way that constitutes that which is new - whether it be a new idea that never before existed, a new plot, a new mousetrap, or a better way of living.

Chapter I of the thesis study attempts to establish the concepts of creativity based on the views of numerous writers of the subject. Here the potency of talent, effort, age, education and knowledge to creative efficacy is evaluated.

Chapter II of the study considers the "creative process" from the "organized" and "inspired" approaches. It is conceded that the creative procedure under the "organized" approach cannot be strictly formulated; but the general phases of orientation, preparation, analysis, hypothesis, incubation, synthesis, and verification are discussed and amplified through relevant quotations from great creative men such as Edison, Pasteur, Einstein and others. The views of Dr. J. B. Conant concerning the non-existence of the scientific method are presented to contrast the opinions of many writers who emphasize existence of the scientific method and advocate its use as a near "cure-all" for most of the ills of society.
Chapter III of the study considers the role of the "professional" or "individual contributor" engaged in creative pursuits in the research laboratories of our modern business enterprises. It is pointed out that many managements are not only uncertain as to just what to call the professional, but confusion exists as to their proper position within the organizational structure of the business enterprise. Through this dilemma the thread of stimulation of creativity in the professional employee is spun. Osborn's "brain-storming technique" and "check list of new ideas", Crawford's "attribute listing", and General Electric's "input-output" scheme are described as stimuli to creativity. A broad philosophy of recognition is outlined advocating realistic job titles and promotional policy, adequate job classifications and proper salary and reward based on individual contribution to the overall effort. The influence of mediocrity in management and work environment on creativity in the professional employee are pointed out as being all important.

In Chapter IV of the study, it is recognized that the "suggestion" of stimuli to creativity in professional personnel is one matter, and the actual "doing" or application of the stimuli is decidedly another. The writer here proposes a program of application of stimuli to creativity in professional employees using the Engineering Research Department of the Ford Motor Company as an example.
CHAPTER I

Creativity

The Essence of Creativity

"Creativity is like another heart. No one has found the source of its power, but no one doubts that the source is within us. It will keep us alive if we give it a chance to beat for us. If we let it be still, there is no more life. It needs continual exercise. If we keep it going strong, it can help us more and more to meet the needs of living."¹

These were the words of Professor Hughes Mearns who devoted his entire career to the teaching of creativity. From 1926 to 1946, he headed the Department of Creative Education at New York University. Unfortunately, Professor Mearns blazed a one-man trail which many educators have shunned.

Civilization, itself, is the product of creative thinking. John Masefield wrote:

"Man's body is faulty, his mind untrustworthy, but his imagination has made him remarkable. In some centuries, his imagination has made life on this planet an intense practice of all the lovelier energies."²

"Nearly all of us are imaginative in our childhood," said Walt Disney. "But, as we grow older, we tend to lose our power of imagination. Failure to flex our imaginative muscles is as deplorable as breaking down our physical strength

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¹ Mearns, Hughes, Creative Power, New York, Doubleday and Company, 1930, p. 56.
through lack of proper exercise."

The term imagination covers a very broad field and takes many forms - some of them berserk, others creative.

The berserk varieties include hallucinations, obsessions and other abnormalities which are beyond the scope of this thesis.

The futile forms include meanderings, as sleep-dreams and day-dreams, and some harmful phases such as complexes, worry and the blues. Our emotions, in the latter forms, tend to allow imagination to work against us. To a worthwhile degree such types of imaginings are conquerable through creative thinking.

There are considered to be three forms of photographic imagination that give us power to visual imagery:

Through speculative imagination we can picture a non-existent island in the sea, for example.

Through reproductive imagination we can recall a scene from the distant past.

Through structural visualization, for example, an automotive engineer can look at a blue print of a future car, and visualize it streaking down a highway.

In addition to photographic imagination, there are three other forms - vicarious, anticipative and creative. The first two forms are not necessarily creative, but can be made

4. Osborn, Alex F., Applied Imagination, New York, Charles Scribner's Sons, 1953, Chapter X.
5. Ibid.
6. Ibid.
to work creatively as will be illustrated.

The first, vicarious imagination, enables us to be someone else. This in itself is not creative; however, if we place ourselves in another person's shoes and imagine how we might help them, this is making creative use of vicarious imagination.

If through anticipative imagination we dilute our minds with ill-boding pictures of what might happen, we are far from thinking creatively. When we allow ourselves to foresee the best, while preparing for the worst, we are making creative use of anticipative imagination.

The highest form of imagination is the creative, and its functions are mainly two-fold. One is to pursue or seek diligently, the other to alter or change.7

In the pursuing function, our talent through imagination may serve as a search light with which we discover that which is really not new, but new to us. For instance, it can be said Newton lighted the unknown but existent truths such as the law of gravity. This is discovery rather than invention.

Considering the change function for a moment, the latter might be compared to the creative actions of a cook, who, through imagination can bring together things or thoughts not new in themselves, but when cooked together constitute that which is new. In this way one does more than discover - he invents - he produces ideas that never before existed.

7. Ibid.
whether it be a new plot, a new mousetrap, or a better way of living.

Thinking is Work

The truly creative form of imagination seldom works automatically; though at times this might not seem so, it is usually because energy is being extended to the imagination. Creativity, therefore, is not merely imagination, but imagination coupled with both effort and intent. This point will subsequently be dealt with in detail.

One of the primary reasons our imaginations tend to backslide is that we tend to coddle our brains rather than to work them in search of ideas.

It is said from the physical standpoint that even if we worked our brains to capacity, we are blessed with far more "grey matter" than we can ever use. Many of our brain centers are in duplicate and act as standbys until through injury or disease a spare is required and trained to take over.

An eminent doctor has stated that an average body is one-half developed and an average brain one-tenth developed. One might candidly deduce then that man could be twice as strong and ten times as intelligent.

Louis Pasteur made some of his greatest contributions to science after a stroke destroyed half his brain.

Alex Osborn quotes Professor William James of Harvard

and George Bernard Shaw respectively:

"Compared to what we ought to be, we are only half awake. We are making use of only a small part of our mental resources", said James.

Shaw agreed with James by his following remark, but he was more dramatic:

"Few people think more than two or three times a year. I have made an international reputation by thinking once or twice a week." \(^9\)

Alex Osborn cites another illustration that is particularly interesting:

"There are some geniuses whose lamps seem to need no rubbing. Alexander Woollcott and I were college mates. His native brilliance dazzled and perplexed me. I had to rub hard to get any rays at all from my little lamp, while his seemed so big that all he needed to do was brush his sleeve against it. And yet, the more I saw of him throughout his later life, the more I realized that his secret was not so much his creative talent as his mental energy." \(^10\)

When it comes to creative efficacy, neither the extent of our knowledge nor the potency of our talent is as vital as our driving power!

Herbert N. Casson of Great Britain emphasized this thought in the following words:

"Why do most people think so seldom? The main reason

\(^9\) op.cit., p. 1.  
\(^10\) op.cit., p. 64.
is that thinking is hard work. It is easy to obey and believe, but it is hard to think. Thought is prevented more by laziness than by any other one thing.

A man is likely to do today what he did yesterday. Why? Because it is easier. Nothing is more comfortable than a rut. That is why most of us are rut-dwellers. We do not even create a rut that fits us. We slip into ready made ruts.

The only way to create a right system for our lives is to have energy and thought - to escape from laziness and tradition. The few who do this become the leaders in all the trades and industries.

The chief obstacle to thinking is not, as many people believe, stupidity. It is rather the disinclination to do real mental work. There are not as many stupid people as lazy people. Most people are sharp enough about things that interest them. And almost everyone has more brain power than he uses. Laziness - inertia - easy-going listlessness, these are the chief preventives of thought.11

Thinking is not easy. It is not as simple a matter as remembering and obeying. It is not repetition work. It is creative!

"What is the hardest task in the world? To think," said Ralph Waldo Emerson.

"To think is to live", said Cicero.12

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11. op.cit., p. 15.
12. op.cit., p. 20
"Who, Me?" --

"Who, Me? I couldn't think up a good idea if I tried."

How many occasions have we had to listen to people express themselves in this manner?

The Human Engineering Laboratories of Stevens Institute, through scientific tests for aptitudes, have revealed the relative universality of creative potential. The majority of writers on creativity investigated generally agree that creative talent is normally distributed, and that our creative efficacy varies more in proportion to personal output of mental energy than in inborn talent. 13

The scientific findings mentioned have been borne out by the countless cases wherein ordinary people have shown extraordinary creative power.

During the war from, 1941 to 1945, the National Inventors' Council in Washington, D.C. received over 200,000 ideas.

During the war, the Army's suggestion system stimulated civilian employees to think up 20,069 new ideas which saved $43,793,000 in 18 months. 14

The war spurred many people to think up many good ideas, and this further substantiates the point that nearly all of us are gifted with creative talent; and that effort, as pointed out before, plays an important part toward activating this talent.

The importance that American business places on ideas is evidenced by the fact that over 6000 companies comprising 20,000,000 employees, now have suggestion systems in operation.15

Every five minutes, 24 hours a day, five days a week, during the first three months of the year 1954, an acceptable suggestion was submitted within the Ford Motor Company under the Employee Suggestion Plan. A total of 19,421 acceptable suggestions was submitted in this quarter to establish an all time high since the plan began in 1947. During January, 1954, 6784 acceptable suggestions set an all time monthly high. During the same quarter $115,247.71 was awarded employees for suggestions put into effect (an average of $50.42 per award). The above amount brought to $2,159,361.20 the total sum paid to employees since the plan was inaugurated in 1947 (an average of $50.05 per award).16

To sustain a nation economy based on more-goods-per-manhour-of-labor, a continual flow of new ideas is imperative.

John A. Barkmeier of Marshall Field recently told 800 leading executives: "The creative thinking of every worker from the bottom to the top of each organization is needed."17

Is Age a Factor in Creativity?

"Experience takes away more than it adds", wrote Plato.

15. Ibid.
17. op.cit., p. 38.
"Young people are nearer ideas than old people."\(^{18}\)

Although there is undoubtedly a certain amount of truth in Plato's remark, there is considerable evidence that tends to refute it.

Goethe, Longfellow, Voltaire, Oliver Wendell Holmes, Milton, David Belasco, Mark Twain, Julia Ward Howe, George Bernard Shaw, Benjamin Franklin and a host of others were creative thinkers and writers after the age of 50 and many did their most creative work between the ages of 70 and 91.

Among recent creative scientists Dr. Albert Einstein is still going strong and the late Dr. George Washington Carver was still turning out new ideas at 80. The New York Times hailed Carver as "the man who has done more than any other man for agriculture in the South".

Henry Ford started the Ford Motor Company in 1903 at the age of 40 and probably did more to put the average man on wheels over the next forty years than any other single person.

Psychologist George Lawton maintains that our mental power can keep on growing until 60. From then on, according to Lawton, mental ability ebbs so slowly that, at 80, it can still be almost as good as at 30. Lawton claims that although older people are apt to lose other faculties such as memory, "creative imagination is ageless."\(^{19}\)

Professor Harvey C. Lehman of the University of Ohio,

\(^{18}\) Ibid., p. 57.
\(^{19}\) Ibid., p. 59
undertook a study covering notables who in their day had thought up ideas of importance to the world. Of better than 1000 creative achievements listed by Lehman, the median age at which creativity occurred was 74.\textsuperscript{20}

The evidence presented thus far has been given to substantiate the point that creativity can be ageless. There are, of course, enumerable examples of creativity at very young ages.

Thomas Alva Edison, for example, published a newspaper before he was 14 and perfected the Universal Stock Ticker at the age of 22 and sold it to Western Union for $40,000.

Is Education A Factor of Creativity?

Doctor L. L. Thurstone says, "To be extremely intelligent is not the same as to be gifted in creative work. This may be taken as a hypothesis.

It is common observation in the universities that those students who have high intelligence, judged by available criteria, are not necessarily the ones who produce the most original ideas. All of us probably know a few men who are both creative and highly intelligent, but this combination is not the rule."\textsuperscript{21}

Thurstone further reasons that if creativity was

\textsuperscript{20} Lehman, H. C., Optimum Ages for Eminent Leadership, Scientific Monthly, February 1942, pp. 162-175.
directly dependent on intelligence, the problem of selecting creative talent would be simple. \(^{22}\)

Thurstone admits little is known concerning creative talent, but he in turn suggests a number of hypotheses about creative talent and the types of observation and experiment by which it might be investigated. He states in one instance that in factorial studies of the primary mental abilities, it has sometimes been found useful to include in the experimental groups, the most extreme differences in the abilities to be analyzed. Applying the same principle toward studying creative talent, one might profit through information gained about the work of geniuses. The writer would like to quote his comments of the manner in which Edison thought and worked—

"Many years ago, I had the privilege of working rather closely with a man who is certainly known to be a genius, and I am trying to recall in the present context some of his intellectual and personality characteristics. Immediately after receiving an engineering degree at Cornell, I went to work with Thomas Edison as one of his laboratory assistants. I talked with him daily and had good opportunity to observe his work habits. He was a man of many strong convictions, and he did not seem to have much admiration for university education. It seems to me that one of his most outstanding characteristics was a tremendous fluency of ideas. For every experimental failure, he seemed to produce three more experiments to try. In this sense, he appeared tireless.

\(^{22}\) Ibid.
The cot in his office was probably used for lying down to think about his problems as often as it was used for sleep. Thomas Edison had a startling fluency of ideas which spread often far from the immediate problem. He seemed to have an absolutely endless array of stories. Few of them were fit for publication. Especially relevant to our present problem is the great fluency in proposing alternative solutions to a problem. This fluency of ideas should certainly be investigated in this context, but I suspect that there may be different kinds of fluency and that all of them may not be equally relevant to creative work. Another characteristic of Edison was the casual way in which he treated experimental failures. These appeared to be merely part of the day's work and the signal for starting another experiment."

History records that many great ideas have come from those devoid of specialized training in the problem involved. For example, the telegraph was worked out by Morse, a professional painter of portraits; the steamboat was put together by Robert Fulton, likewise an artist; and Eli Whitney a school teacher, devised the cotton gin and the practical application of interchangeability of parts.

An unscientific employee of New York City's transit system thought up a new shell-fragment detector that saved many lives during the war.

There are many other cases where untrained people have

23. Ibid., pp. 29-30.
creatively out-thought the highly trained.

Creativity in our population can be our greatest national asset.
CHAPTER II

The Creative Process

The creative process cannot be rigidly methodized.

The approaches to the creative problem appear to divide themselves into two general classes - the "organized" and the "inspired" approach.

From those who have studied and practiced organized creativity, it is conceded that the creative procedure might never be strictly formulated; but in general the phases usually include the following, not necessarily expressed in these exact words or steps:

(Alex Osborn's Listing)

1. Orientation: Pointing up the problem.
2. Preparation: Gathering pertinent data.
3. Analysis: Breaking down the relevant material.
4. Hypothesis: Compiling alternatives by way of ideas.
5. Incubation: Letting up to invite illumination.
7. Verification: Judging the resultant ideas.¹

Professor John Arnold, Head of M.I.T.'s Creative Engineering Laboratory, believes his four steps coincide with Osborn's seven steps; but in addition, he believes his four steps - question, observe, associate, and predict hold in every act of innovation, from the lowest level to the highest.²

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Arnold hastens to define his terminology "levels of creativity" as being based on complexity, not on social value. Any new combination that better satisfies some need and is put into practice is creative, even though the newness of the pattern is restricted to you alone.3

Rather than discussing the pros and cons of order, number of steps and the like in the creative process, it would perhaps be of greater value to discuss the meaning and content of the phases listed as arbitrarily making up the creative process with the thought of increasing creative output or efficiency.

The Organized Approach

Orientation - Pointing up the problem, or in other words, the problem statement is probably one of the most important steps in the creative process.

The problem statement actually involves two steps:
1. Awareness that a problem exists.
2. Careful defining of the problem so that it can be solved in the most realistic manner.

Once one is aware of a problem, one must then be able to state it clearly and precisely and be able to communicate it to others.

Hugh Walpole in his book on Semantics stated:
"Our interpretation of an utterance may be said to fall into three stages - What we think it might mean, What

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3. Ibid.
we think it does mean, and What we think of it. Our effectiveness at the second stage depends entirely upon our success with the first, and the last stage depends on the second. 4

Alex Osborn states the problem should be written out to help force creative action. From personal experience the writer agrees with this statement but for an equally or more important reason. In cases where the problem statement originates several management levels above the supervisor whose group will have the responsibility for solving the problem, the true intent or statement of the problem is lost as it is passed verbally through the succeeding levels of management to the final supervisor whose group will have to do the work.

Aside from a written statement of the problem to preserve its true intent, the writer believes that in Engineering Research for example, short top management conferences should be called, involving those levels concerned, including the supervisor whose responsibility it will be to solve the problem and that level of management initiating the problem. In this manner everyone is acquainted with the true intent and thinking of the undertaking; differences of opinion are reconciled in the beginning, or if not, they are at least established. In numerous cases in the writer's experience needless work, thought and time could have been saved had this procedure been followed; and, likewise in cases where the procedure was followed, these savings were realized.

Alex Osborn quotes John Dewey: "A problem well stated is half solved". Osborn further states: "It is just as true that the more we narrow it down, the nearer we get to its solution."5

The writer is inclined to regard the latter statement as "questionable" and present John Arnold's thoughts on the point as being more realistic from the standpoint of encouraging "creativity" in designers and research people:

"I see no reason why researchers or designers can't be as creative and imaginative as management, and when they can't start out with a very broad viewpoint and eventually narrow the problem down. The creative designer should be expected to look into all possible approaches, to formulate and re-formulate problems and sub-problems until he finds a solution that satisfies as many of the prime goals of the initial problem as time and expenses allow."6

Arnold further adds:

"There is no question but that all directives, except those of an exploratory nature of very broad scope, should contain a listing and discussion of the limitations that should be considered in carrying out a project. These limitations can't help but have an inhibiting effect on the imagination of the designer, but they are frequently required because of manufacturing methods readily available, marketing and pricing policy and general economic conditions. Any

5. op.cit., p. 134
limiting factor, however, should be given careful consideration before including it in the directive; and then only when it is vital to the success of the project. Try and stimulate rather than restrict the thinking of the researcher or designer!"  

It can be said that in general industry is interested in four types of problems depending on whether it is specific or general and of immediate need or long range.

The writer would like to cite from recent experience a problem that was approached with four separate investigations that exemplify the four types of problems named above.

The general problem can be thought of as increasing the stopping ability of an automobile.

The general-long range investigation was then stated as "investigate and devise means of increasing the stopping ability of an automobile."

We see here the designer or research engineer is hardly limited in the extent to which he can go toward devising means of stopping a car. Perhaps conventional wheel drumshoe type brakes are not the answer; an air-flap type brake might suffice, working in conjunction with the engine; or a drive shaft brake-mechanical, electrical or hydraulic or combinations thereof. Perhaps the solution is a compromise using conventional brakes at the wheel with a secondary brake at high speeds of one of the other means mentioned.

7. Ibid.
The long range, more specific investigation was broken down into two parts - the first or preliminary stage was immediate, specific - "determine the relative advantages and disadvantages of a disc type wheel brake over our conventional wheel shoe-drum type brake. If the apparent advantages of a disc type wheel brake are further confirmed, design, build and test a wheel brake of the disc type for adaptation to Lincoln Car."

Immediate-general was stated in this investigation - "devise means of improving the heat rejection of the production Lincoln Car brake".

Immediate-Specific was stated in this investigation - "determine the improvement (if any) in brake performance for the production Lincoln Car for the following three combinations -

1. Keep the diameter of the brake constant and increase the width.
2. Keep the width constant and increase the diameter.
3. Increase both width and diameter.

Design of adjacent components must stay the same except for wheel hub and wheel spider."

Again the problem statement should be defined in as general, broad terms as possible, consistent with sound economic policy wherein possible gain is weighted against sure expenditure.

Preparation and Analysis - There is apparently dis-
agreement among creative people as to the extent one should collect data in preparation for a creative undertaking.

In some creative undertakings perhaps there is no background material available; in other instances where material is available (based on efforts of those faced with the same problem or a problem whose results are important to one's line of thinking), it would seem unreasonable not to cover this material simultaneously applying one's own imagination and judgment to the facts as presented.

Some people in creative work believe that knowledge of other's successes or failures have an inhibiting influence on their own imaginations and hamper their search for new ideas. Others feel it is most important to take advantage of previous experiments - their merits and their weaknesses.

Be this as it may, perhaps this is an opportune time to relate what are considered to be the prime methods of attack under the "organized" branch of creativity - for the writer believes this has important bearing on the extent to which background material is gathered and analyzed.

The first method is called the Baconion or, more recently, the Edisonion method "try-it-and-see". In the words of L. W. Rapeer, "The audacious capture - ferocious elimination." 8

Mr. M. A. Rosanoff revealed in his interesting article on his life and work with Edison the following conversation

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which I believe is to the point and also contrasts with the quoted experience of Thurstone (Page 11 of this thesis).

"One day the Old Man (Edison) sat down for a chat; and we exchanged confidences. 'Do you believe in luck?', he asked me. I said, 'Yes and no. My reasoning mind revolts against the superstition of luck; my savage soul clings to it.' 'For my part,' said the Old Man, 'I do not believe in luck at all. And if there is such a thing as luck, then I must be the most unlucky fellow in the world. I've never once made a lucky-strike in all my life. When I get after some thing that I need, I start finding everything in the world the I don't want - one dern thing after another!

I find ninety-nine things that I don't need; and then comes number one hundred, and that - at very best - turns out to be just what I had been looking for. It's got to be so that if I find something in a hurry, I get to doubting whether it's the real thing; so I go over it very carefully, and it generally turns out to be wrong. Wouldn't you call that hard luck?

But I'm telling you I don't believe in luck, good or bad. Most fellows try a few things and then quit. I never quit until I get what I'm after. That's the only difference between me - that's supposed to be lucky - and the fellows that think they are unlucky.

Then again, a lot of people think I have done things because of some genius that I've got. That, too, is not true. Any other bright-minded fellow can accomplish just as much if he will stick like hell and remember that nothing that's
any good works by itself, just to please you; you've got to make the dern thing work! You may have heard people repeat what I have said, 'Genius is one per cent inspiration, ninety-nine per cent perspiration'. Yes, sir, it's mostly hard work! I said, 'You will admit, Mr. Edison, that at least your patience is out of the ordinary?' 'Oh, yes,' he replied, 'I've got lots of patience.'"

Edison's attitude of distrust of the more deductive method of using general principles, criteria, and standards to cut down the labor and loss of mechanical elimination is expressed from the same article below in the words of Rosanoff:

"'And as he became aware that, by natural inclination, I was forever struggling for some theoretical guide-light, he undertook a persistent campaign of re-educating my mind. By way of a morning greeting, he got to screwing up his face into a disdainful grimace and calling out, 'How is theoretical chemistry this morning?' He began telling me stories of the triumph of his almost helter-skelter, trial-and-error method over the prophecies of engineers based on scientific theory. One day he asked me to guess what material had made the first promising filament for the incandescent lamp.

'You couldn't guess it in a hundred years,' he said. 'Limburger cheese! Now, can you show me a book of theoretical chemistry that explains why limburger cheese must be good for the incandescent lamp?'" 9

The second method of attack is erroneously labelled the Aristotelian method, for lack of a better name. Hans Zinsser writing about Charles Nicolle, the great French bacteriologist, was one of many who successfully utilized this method, said:

"Nicolle was one of those men who achieve their success by long preliminary thought before an experiment is formulated, rather than by frantic and often ill-conceived experimental activities that keep lesser men in ant-like agitation. Indeed, I have often thought of ants in observing the quantity output of 'what-of-it' literature from many laboratories... Nicolle did relatively few and simple experiments. But every time he did one, it was the result of long hours of intellectual incubation during which all possible variants had been considered and were allowed for in the final tests. Then he went straight to the point, without wasted motion. That was the method of Pasteur, as it has been of all the really great men of our calling, whose simple, conclusive experiments are a job to those able to appreciate them."\(^\text{10}\)

John Arnold and other writers mention a third method of attack which is more or less a combination of the first two and is used throughout much of industry today. Arnold cites as contrasting examples the work of the late Thomas Midgley, Jr. and his associates, who, after a long period of experimentation, discovered the effectiveness of tetra-

\(^\text{10} \text{op.cit., p. 39.}\)
ethyl lead in inhibiting fuel knock in internal combustion engines (Edisonion Method). At the other extreme, Midgley's research leading to the use of fluorinated hydrocarbons as safe refrigerants was accomplished in three days by means of his creative imagination, careful analysis, the observation of the periodic table and a minimum of experimentation.\textsuperscript{11}

It can be seen from the related instances that the amount of background information theory and experimentation vary considerably in the cases of even the great men of science.

\textbf{Hypothesis}

The fourth step, that of hypothesizing or speculating on possible solutions, is one of the most important of all.

John Arnold warns, \textit{"Don't mix evaluation with imagination.} There is nothing more devastating to the flow of ideas than to dash them with some cold judgment. Evaluation has an important but definite place in the sequence - it comes after you have thought up all the ideas that you possibly can."\textsuperscript{12}

Paul deKruif said of Louis Pasteur:

\textit{"This man was a passionate groper whose head was incessantly inventing right theories and wrong guesses - shooting them out like a display of village fireworks going off bewilderingly by accident."}\textsuperscript{13}

\begin{thebibliography}{13}
\bibitem{11} op.cit.\textemdash, p. 39.
\bibitem{12} Ibid., p. 41.
\bibitem{13} DeKruif, Paul H., Microbe Hunters, New York, Harcourt, Brace and Company, 1928, p. 206.
\end{thebibliography}
Our progress toward solution of a creative problem is very likely to depend on the extent to which we pile up hypotheses. The more ideas or possibilities we conceive, the more likely we are to find the key to the problem solution. The odds are that but a few of the ideas hit upon will be any good. Then, too, the more ideas that are consciously gathered the more our automatic power of association is primed.

Alex Osborn says, "Quantity, quantity, and more quantity! This should be the order of the day when building up hypotheses".

Admittedly, there are some who doubt the need of quantity in idea-production. Osborn tells of a publisher who once remarked, "Don't bother about thinking up a lot of ideas. Just think up one or two good ideas". It would appear, however, that logic and mathematics are on the side of the statement that the more ideas that are produced, the more the likelihood is that some will be good.

Dr. James B. Conant, former President of Harvard, related speculative ideas, working hypotheses, and conceptual schemes in the following manner:

"A conceptual scheme, when first formulated, may be considered a working hypothesis on a grand scale. From it

15. Ibid.
one can deduce, however, many consequences, each of which can be the basis of chains of reasoning yielding, deductions that can be tested by experiment. If these tests confirm the deductions in a number of instances, evidence accumulates tending to confirm the working hypothesis on a grand scale, which soon becomes accepted as a new conceptual scheme. Its subsequent life may be short or long - for from it, new deductions are constantly being made which can be verified or not by careful experimentations.16

Webster's Dictionary defines hypothesis in the following manner:

"1. A tentative theory or supposition, provisionally adopted to explain certain facts and to guide in the investigation of others;--frequently called a working hypothesis; as, the nebular hypothesis. 2. Something assumed or conceded merely for the purposes of argument or action; as, start with this hypothesis.

Hypothesis implies insufficiency of presently attainable evidence and, therefore, a tentative explanation; theory implies a much greater range of evidence and likelihood of truth; law implies a statement of order and relation in nature that has been found to be invariable under the same conditions. The terms are not rigidly applied, however, as the discovery of new evidence often changes the status of

the formula."\textsuperscript{17}

Louis Pasteur between the years 1870-1872, undertook and completed his revolutionary studies of ferments in beer. He foresaw the distant consequences of these studies and wrote the following hypothesis which is significant, but even more so is his statement regarding a hypothesis in itself:

"When we saw beer and wine subjected to deep alterations because they have given refuge to micro-organisms invisibly introduced and now swarming within them, it is impossible not to be pursued by the thought that similar facts may, must, take place in animals and in man. But if we are inclined to believe that it is so because we think it likely and possible, let us endeavor to remember, before we affirm it, that the greatest disorder of the mind is to allow the will to direct the belief."\textsuperscript{18}

The above paragraph indicates the quality of the inspired Pasteur who associated in his person the faith of an apostle with the inquiring patience of a scientist.

One has only to read Pasteur's own words in his detailed accounts of his life's work (that made Pasteur a household word in the civilized world) to realize the importance


of hypotheses followed by experimental proofs.

**Incubation** - As a part of the creative process, incubation does not necessarily follow the previous step of hypothesis. It may or may not come into the process at all, again depending on the particular problem or idea.

The term incubation in the creative process implies a relaxation of mental effort toward one problem, especially if the extended effort has been exhausting mentally, and experimental testing of hypotheses have proved "blind alleys". The mental relaxation of the incubation period may take many forms, i.e.:

1. Sleep
2. Physical rest, mental muse.
3. Any form of physical exercise.
4. Mental diversion extending from jig-saw puzzles to a second or third creative problem.
5. Relaxed reflection rather than forced thinking.

In many instances, while the conscious mind is diverted, the unconscious relentlessly turns the problem over and over and the solution may suddenly occur as a "flash" at the most unexpected moment.

**Synthesis** - Synthesis is the opposite of analysis; yet in the solution of most creative problems the two go hand in hand. The more intelligently a problem can be broken down into simple pieces (analysis), the more apt one is to fit the correct pieces together into a new whole or idea (synthesis).
The act of synthesizing usually entails a process of induction through which by logical steps, one seeks to merge several specific ideas into a more general one.

The writer believes Max Wertheimer's description and analysis of Einstein's thinking that led to the Theory of Relativity provides several examples of synthesis and analysis, wherein he repeatedly re-examined the theoretical situation concerning light, time, and Michelson's experiment. Einstein said to himself:

"Except for that result, the whole situation in the Michelson experiment seems absolutely clear; all the factors involved and their inter-play seem clear. But are they really clear? Do I understand the structure of the whole situation, especially in relation to the crucial result?"

Wertheimer carried on to say that Einstein faced the essentials in the Michelson situation again and again especially the point concerning the measurement of the speed of light under conditions where the measuring apparatus (by mirror interference) was moving in a direction toward the light source. This simply would not become clear. He felt a gap somewhere without being able to clarify it, or even formulate it. It occurred to Einstein suddenly that time measurement involved simultaneity. He said to himself:

"What of simultaneity in such a movement as this? To begin with, what of simultaneity of events in different

places? If two events occur in one place, I understand clearly what simultaneity means. For example, I see these two balls hit the identical goal at the same time. But -- am I really clear about what simultaneity means when it refers to events in two different places? What does it mean to say that this event occurred in my room at the same time as another event in some distant place. Surely I can use the concept of simultaneity for different places in the same way as for one and the same place -- but can I? Is it as clear to me in the former as it is in the latter case? It is not! 20

"From the moment, here, that Einstein realized the customary concept of time and its measurement were not independent of the conditions of movement of the system in relation to the observer, it took him only five weeks to write his paper on relativity -- although at this time he was doing a full day's work at the Patent Office." 21

It is thus seen that many times in the solution of a creative problem, the mere following of the suggested steps thus far does not automatically give the solution. Seldom does the creative problem lend itself to ready solution in such paper work fashion. The assumptions, theories, analytical or logic reasoning, and hypotheses must be re-analyzed, re-synthesized until verification is attained -- the latter term will be the final step discussed.

20. Ibid.
Verification - The final phase of the creative process essentially calls for judgment rather than imagination. As has been pointed out previously, judgment may be exercised at any point through the creative process; but on the other hand, it must be applied with discretion lest the imaginative process be depressed.

The surer form of verification is testing, but the latter process must not be viewed as a simple one. Many erroneous conclusions have been drawn (in the writer's experience) from test results - either through poorly conducted tests or improper analysis and judgment of test data.

Louis Pasteur, often called the father of the experimental method, was quoted one day in 1873, during the period of the most ardent polemics, in the midst of the struggle on spontaneous generation. A medical man named Declat who declared that Pasteur's experiments were "the glory of our century and the salvation of future generations", gave a lecture on "The Infinitesimally Small and Their Role in the World." "After the lecture," relates Dr. Declat himself, "Mr. Pasteur, whom I only knew by name, came to me and, after the usual compliments, condemned the inductions I had drawn from his experiments. "The arguments," he said, 'by which you support my theories, are most ingenious, but not founded on demonstrated facts; analogy is no proof.'" 22

At the Académie de Médecine in the year 1875, Pasteur had occasion to respond to a Mr. Poggiale, formerly apothe-
cary-in-chief to the Val de Grace, who gave a somewhat skeptical dissertation on such a subject as "spontaneous generation" (a controversial subject for nearly 200 years). The remark that occasioned Pasteur's response is given below, for the writer believes this response is most appropriate for not only the verification step but the entire creative process:

"M. Pasteur has told us that he had looked for spontaneous generation for twenty years without finding it; he will long continue to look for it, and, in spite of his courage, perserverance and sagacity, I doubt whether he ever will find it. It is almost an unsolvable question. However those who, like me, have no fixed opinion on the question of spontaneous generation reserve the right of verifying, of sifting and of disputing new facts, as they appear, one by one and wherever they are produced."

"What!" cried Pasteur, wrathful whenever those great questions were thoughtlessly tackled, "what! I have been for twenty years engaged in one subject and I am not to have an opinion! and the right of verifying, sifting, and disputing the facts is to belong to him who does nothing to become enlightened but merely to read our works more or less attentively, his feet on his study fender!!!

You have no opinion on spontaneous generation, my dear colleague; I can well believe that, while regretting it. I am not speaking, of course, of those sentimental opinions that everybody has, more or less, in questions of this nature,
for in this assembly we do not go in for sentiment. You say that, in the present state of science, it is wiser to have no opinion. Well, I have an opinion, not a sentimental one, but a rational one, having acquired a right to it by twenty years of assiduous labor, and it would be wise in every impartial mind to share it. My opinion--nay, more, my conviction--is that, in the present state of science, as you rightly say, spontaneous generation is a chimera; and it would be impossible for you to contradict me, for my experiments all stand forth to prove that spontaneous generation is a chimera. What is then your judgment on my experiments? Have I not a hundred times placed organic matter in contact with pure air in the best conditions for it to produce life spontaneously? Have I not practiced on those organic materia which are most favourable, according to all accounts, to the genesis of spontaneity, such as blood, urine, and grape juice? How is it that you do not see the essential difference between my opponents and myself? Not only have I contradicted, proof in hand, every one of their assertions, while they have never dared to seriously contradict one of mine, but, for them, every cause of error benefits their opinion. For me, affirming as I do that there are no spontaneous fermentations, I am bound to eliminate every cause of error, every perturbing influence, I can maintain my results only by means of most irreproachable experiments; their opinions, on the contrary, profit by every insufficient experiment and that is where they find their support."
Pasteur having been abruptly addressed by a colleague, who remarked that there were yet many unexplained facts in connection with fermentation, he answered by thus apostrophizing his adversaries—

"What is then your idea of the progress of Science? Science advances one step, then another, and then draws back and meditates before taking a third. Does the impossibility of taking that last step suppress the success acquired by the two others? Would you say to an infant who hesitated before a third step, having ventured on two previous ones: 'Thy former efforts are of no avail; never shalt thou walk'?

You wish to upset what you call my theory, apparently in order to defend another; allow me to tell you by what signs these theories are recognized: the characteristic of erroneous theories is the impossibility of ever foreseeing new facts; whenever such a fact is discovered, those theories have to be grafted with further hypotheses in order to account for them. True theories, on the contrary, are the expression of actual facts and are characterized by being able to predict new facts, a natural consequence of those already known. In a word, the characteristic of a true theory is its fruitfulness."

"Science," said he again at the following sitting of the Academy, "should not concern itself in any way with the philosophical consequences of its discoveries. If through the development of my experimental studies I come to demonstrate that matter can organize itself of its own accord into a
cell or into a living being, I would come here to proclaim it with the legitimate pride of an inventor conscious of having made a great discovery, and I would add, if provoked to do so 'All the worse for those whose doctrines or systems do not fit in with the truth of the natural facts.'

It was with similar pride that I defied my opponents to contradict me when I said, 'In the present state of science the doctrine of spontaneous generation is a chimera.' And I add with similar independence, 'All the worse for those whose philosophical or political ideas are hindered by my studies.'"23

Inspired Creativity

According to Doctor William Easton, our feelings are the stronger and more common source of creative energy. He said:

"Even scientists must be motivated by enthusiasm, devotions, and passions; for creative thinking is not a purely intellectual process. On the contrary, the thinker is dominated by his emotions from the start to the finish of his work."24

Creativity can be inspired or depressed (there are many examples of both) through fear, love, hate, ambition, greed, and adversity.

Rene Vallery-Radot, writing of Louis Pasteur's life, describes how Pasteur (from his own writings) was constantly

23. Ibid., pp. 242-244.
haunted in his mind by one mystery that took precedent over all of his laboratory researches - that of hydrophobia.

One of Pasteur’s childhood recollections (night in October, 1831) was the impression of terror produced throughout the Jura by the advent of a rabid wolf who had bitten countless men and beasts. In the neighborhood eight victims, bitten about the head and arms, succumbed to hydrophobia, and amidst horrible sufferings, they died.

This and other similar instances remained vivid throughout his life and these finally, coupled with the countless remedies amounting to quackery on the part of doctors, forced Pasteur in 1882 to seek an understanding of hydrophobia and a vaccine to cure its victims. After three long years of experimentation and study, spurred on by every day deaths of children and adults around him, he injected vaccine into his first human being on July 6, 1885. A small boy, severely bitten about his body and hardly able to walk, was brought to him. After much deliberation and consultation with Mr. Vulpian, head of the Rabies Commission, it was decided that the boy’s case was a lost one unless the vaccine, which had proved successful with dogs, were used. The boy was inoculated twelve times in ten days and lived.

It could be said that fear and a desire to eliminate death and suffering caused by bites from rabid animals pushed Pasteur into this new field where he again distinguished himself in the cause of mankind.25

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25. op.cit., pp. 408-417
Professor John Arnold of M.I.T. has said:

"It is my thesis, however, that the big steps, the fulfillment of new needs, the establishment of new industries, are accomplished through the 'inspired' approaches." 26

The "Ballyhoo" of the Scientific Method

In the description and discussion of the "Creative Process", the writer has endeavored not to create the impression that the steps as outlined constitute "the method". For the purpose of further emphasizing this point of view, it is believed the discussions of Dr. James B. Conant, former president of Harvard University, on the subject of "The alleged scientific method" taken from his book "Science and Common Sense" would be most appropriate.

Dr. Conant continually stresses the part played by creative imagination in science; and further abhors the static conception of science as a body of truths. He believes that science is dynamic and a creative process. He says "Science is that portion of accumulative knowledge in which new concepts are continuously developing from experiment and observation and lead to further experimentation and observation". 27

Dr. Conant objects to those writers, Karl Pearson for one, who expound the existence of the scientific method. He feels it reflects a persistence belief in the correctness of

27. op.cit., p. 25.
the analysis of science and makes the methods of science appear to the layman, all too simple. He says,

"The stumbling way in which even the ablest of the scientists in every generation have had to fight through the thickets of erroneous observations, misleading generalizations, inadequate formulations, and unconscious prejudice is rarely appreciated by those who obtain their scientific knowledge from text books. It is largely neglected by those expounders of the alleged scientific method who are fascinated by the logical rather than the psychological aspects of experimental investigations."

To attempt to formulate in one set of logical rules the way in which mathematicians, historians, archaeologists, philologists, biologists, and physical scientists have made progress would be to ignore all the vitality in these varied undertakings.

To be sure, it is relatively easy to deride any definition of scientific activity as being oversimplified, and it is relatively hard to find a better substitute. But on one point, I believe almost all modern historians of the natural sciences would agree and be in opposition to Karl Pearson. There is no such thing as "The" scientific method. If there were, surely an examination of the history of physics, chemistry, and biology would reveal it. For as I have already pointed out, few would deny that it is the progress in physics, chemistry, and experimental biology which gives everyone confidence in the procedures of the scientist. Yet, a
careful examination of these subjects fails to reveal any one method by means of which the masters in these fields broke new ground."\textsuperscript{28}

Dr. Conant continues:

"I have read statements about the scientific method which describe fairly accurately the activity of an experimental scientist on many occasions (but not all). They run about as follows:

1. A problem is recognized and an objective formulated.
2. All the relevant information is collected (many a hidden pitfall lies in the word 'relevant!).
3. A working hypothesis is formulated.
4. Deductions from the hypothesis are drawn.
5. The deductions are tested by actual trial.
6. Depending on the outcome, the working hypothesis is accepted, modified, or discarded.

If this were all there were to science, one might say, in the words of a contemporary believer in the scientific method, that science as a method 'consists of asking clear, answerable questions in order to direct one's observations which are made in a calm, unprejudiced manner, reported as accurately as possible and in such a way as to answer the questions that were asked to begin with; any assumptions that were held before the observations are now revised in the light of what has happened'. But if one examines his own

\textsuperscript{28} Ibid., p. 45.
behavior whenever faced with a practical emergency (such as the failure of his car to start) he will recognize in the preceding quotation a description of what he himself has often done. The layman confronted with some such description of science is in a similar situation of that of the famous character in Moliere's comedy who had been speaking prose all his life without knowing it."29

Dr. Conant relates how Galvani got the first trace of electricity from the twitching of a dead frog. There developed a hot controversy between Galvani's disciples (Galvani died in 1798) and Volta about whether or not there was such a thing as animal electricity and what caused the twitching of the frog's leg in the first experiment. Volta, in an effort to obtain better detection of small charges of electricity, invented the battery. In a sense we have not yet finished with Galvani's first experiment but have finished with Volta's discovery. In the former question of Galvani's, one working hypothesis still replaces another and new experiments continually throw new light on old observations. In the original question, Volta lost interest, yet he discovered the battery - such is often the case in scientific history where a problem is solved other than the one first at issue.

Elliott Dunlap Smith claimed that experimentation could

29. Ibid, p. 50.
never be a machine into which a coin could be placed and the answer received on a neatly printed card. He carefully traced the steps that led to typical inventions and concluded: "The act of inventiveness which achieved the solution was not logical scientific thought at all. Unless the inventor is willing to relax the meticulous step-by-step procedure of logical science, he will get nowhere." 31

Dr. Suits of General Electric stated:

"It's generally a hunch that starts the inventor on his quest. Later on, perhaps after weeks of fruitless searching another inspiration arriving when he least expects it, drops the answer in his lap. I've seen this happen over and over. But I've yet to meet that 'coldly calculating man of science' whom the novelists extol. Candidly, I doubt that he exists; but if he did exist, I fear he would never make a startling discovery or invention".

31: Ibid., p. 50.
CHAPTER III

The Stimulation of Creativity in Professional Personnel

The Need of More Thinking

Thinking is as necessary to a business as capital. A business may have an abundance of capital and without thinking - easily fail. With plenty of thinking, however, a business is not likely to fail. Capital may earn 5%, but thinking, plus capital, might earn 40%.

When a firm stops thinking, it can go adrift and move only by the pressure of its correspondence and routine. Competitors move ahead when its progressive thinking has ceased. It follows the line of least resistance; it has stopped doing the hard work (thinking) and does only what it must do and no more. This is drifting; and no firm every drifted into big profits. It usually drifts to loss and disaster.

The manager of any firm or group of people needs the help of everyone in the group or firm in suggesting improvements. More headwork! More thinking! That is what is needed all along the line. There should be a group of thinkers in every firm.

A manager needs all the brain-power of his staff--he may have authority, but power does not insure thought. A firm or group should be managed by authority plus knowledge plus thinking.

A manager must do all he can to stimulate his people to think, for he can learn not only from his group of specialists, but his employees as well. He pays for thoughts - he develops the brain power of his people - he does not crave the
honor of being the only thinker in the firm or group.

The writer believes there is no more hopeful sign of progress along these lines than the increased interest today in research. Translated into other terms, this means that industry is creating "thinking departments". It is organizing its thinkers and equipping them with laboratories, tools, materials and machinery. In short, it is spending money on thought.

Just before and during World War I, organized research as an adjunct to industrial companies began to appear in the United States. In the interim period the development has been rapid and revolutionary in its consequences.

The number of persons employed in industrial research has risen from approximately 10,000 at the end of World War I to 50,000 at the outbreak of World War II. By the year 1949, the number exceeded 130,000 people.

The total expenditure in this country for research and development work by industry, government, universities and research institutes has been estimated at 160 million dollars in 1930, 350 million in 1940, a half a billion dollars in 1948 and approximately 4 billion in 1954. In the words of Dr. James B. Conant:

"The order and magnitude of these figures indicates a transformation within a generation of an enterprise carried on by a handful of men to a social phenomenon of tremendous significance."¹

Both research and development work are lumped together in the aforementioned statistics, and the breakdown for research alone is not available to the writer's knowledge. The amount of money spent on research alone might be misleading if the combined figures are used for sole judgment of this point.

Defining the Area

The term "research" can be somewhat ambiguous. W. R. Maclaurin's terminology and breakdown for research and development is given below:

1 - **Fundamental Research** - The development of new concepts and improvement of older ones, as well as exploration with new instruments and new techniques.

2 - **Applied Research** - The application of existing conceptual schemes to the solution of practical problems. The exploration of practical uses of new experimental discoveries and the accumulation of factual information for immediate practical ends.

3 - **Engineering Development**

4 - **Production Engineering**

The boundary between engineering development and production engineering is hazy in some respects. Development work usually involves the first steps in reducing ideas to industrial practice. Generally speaking, engineering development concerns pilot plants and the like, while production engineering concerns improvements in actual large-scale operating units.
5 - Service Engineering - These people are in close contact with the sales department and hence the customer.

Defining the people

The fields encompassed by Applied Research and Engineering have widened rapidly since World War II. The layman who hears the term "research engineer" usually envisions a chemist pouring smoking liquid from a test tube into a smoking flask being heated over a Bunsen burner. Yet, today our research engineering facilities are staffed with physicists, geologists, biologists, electronic-aeronautical - mechanical - electrical - civil - hydraulic-rocket and automotive engineers. In addition, we have the statisticians, economists, certified public accountants, psychologists, doctors and lawyers. This list is by no means complete. Our ever increasing technology has created entirely new fields of research engineering and is bringing into the business enterprise large numbers of the above mentioned specialists. The terms "engineer", "scientist", and "research engineer" are becoming broad and more obscure. In reality this entire group constitute "professional employees". The latter term does not really suffice for it implies college degrees and the like and this is not always the case. Yet many through individual accomplishment in their respective fields have achieved the status of research engin-

eer or professional employee.

Peter Drucker, industrial consultant, comments in his latest book:

"Wherever I go I find concern with the proper organization of these professional and technical experts. Yet so new is the phenomenon that we do not even really know what to call the professional employee. Only General Electric has coined a term; it calls these men 'individual professional contributors'. Debatable as the term is (for these people usually do not work individually but in teams), it will have to do until a better one comes along." 3

The writer is primarily directing Chapter III to this professional group and those aspiring to become its members; though in most cases, the stimulation of the concepts of creativity could be applied to almost anyone, anywhere.

Recognize Inhibiting Factors to the Creative Process

In stimulating the concepts of creativity in professional personnel, a useful technique involves the recognition of some of the inhibiting factors concerning creativity.

Professor John Arnold of M.I.T. believes these factors fall into the following three areas:

1. Perceptual Area - the receiving of information about the real world in order to become aware of the problems that exist there and in order to obtain the necessary information and data to approach a solution to these problems.

2. **Cultural Area** - We must associate with other living things and the products of their efforts - these have a tremendous influence on our thinking.

3. **Emotional Area** - Those factors generated by our emotions.

Professor John Arnold and Alex Osborn list a number of blocks to creativity falling within these three areas. While the areas themselves are distinct, the blocks are somewhat complex and frequently mixtures of these areas. The following list is by no means complete:

**Perceptual Blocks**

1. Difficulty in isolating the problem (can't separate object from field).

2. Difficulty in narrowing the problem too much (paying little or no attention to the environment).

3. Inability to define terms or isolate attributes.

4. Failure to use all of the senses in observing.

5. Difficulty in seeing remote relationships (inability to transfer).

6. Difficulty in not investigating the "obvious".

7. Difficulty arising from not recording "trivia".

8. Difficulty arising from conceptualizing on the basis of superficial likeness (overemphasis on past experience).

9. Failure to distinguish between cause and effect.

10. Difficulty in working with false data (using concepts derived in one field and applied to another where they don't apply).

Cultural Blocks

1. Desire to conform to an accepted pattern.
2. Must be practical and economical above all things so that judgment comes into play too quickly.
3. Not polite to be too inquisitive and not wise to doubt everything.
4. Overemphasis on competition or in cooperation.
5. Too much faith in statistics.
6. Difficulties arising from over-generalization.
7. Too much faith in reason and logic.
8. Tendency to follow the all-or-nothing attitude.
9. Too much or too little knowledge about the field that you are working on.
10. Belief that indulging in fantasy is a waste of time.

Emotional Blocks

1. Fear of making a mistake or making a fool of yourself.
2. Difficulty in rejecting a workable solution and searching for a better one (grabbing the first idea that comes along).
3. Difficulty in changing set (no flexibility, depending on biased opinion).
4. Over-motivation to succeed quickly.
5. Pathological desire for security (no desire to pioneer or gamble).
6. Fear of supervisors and distrust of colleagues and subordinates.
7. Lack of drive in carrying problem through to completion and test.
8. Lack of drive in putting solution to work.
9. Inability to relax and let "incubation" take place.
10. Refusal to take detour in reaching goal.

Without a detailed discussion of each of these blocks, it is believed that the mere recognition or awareness may release some of their inhibiting power.

Other Methods to Stimulate Creativity

Osborn's "Brainstorming Technique" - In the year 1939, Alex Osborn organized a group thinking technique dubbed by the first participants "brainstorming". Apparently this was done very aptly for the technique involves using the brains of a number of people to storm a creative problem in "commando" fashion.

The procedure is quite simple - one man assumes the role of chairman and another the recorder. The chairman states the problem as clearly and concisely as possible. Here the problem must not be broad and general but more narrow and specific: otherwise, the important aspects of group feedback or cross-stimulation is minimized. If the problem cannot be narrowed, it must be broken into pieces and stormed one aspect at a time.

After the chairman has stated the problem, the group goes to work thinking up ideas and stating them as fast as possible. No criticism or evaluation of ideas is permitted.

5. Ibid., pp. 53-54.
As Alex Osborn has put it:

"If you try to get hot water and cold water out of the same faucet at the same time, you will get only tepid water. If you try to criticize and create at the same time, you can't turn on either cold enough criticism or hot enough ideas."

The evaluation or judgment of the ideas should take place the next day, preferably by members of the same group, since they have had several new ideas arise as a product of the sub-conscious mind (incubation). These ideas should be listed before the final act of evaluation.

Osborn further lists four basic rules that must be observed if such idea-producing sessions are to be fruitful:

1. "Judicial judgment is ruled out. Criticism of ideas must be withheld until later.
2. 'Free-wheeling' is welcomed. The wilder the idea, the better; it is easier to tame down than to think up.
3. Quantity is wanted. The greater the number of ideas, the more the likelihood of winners.
4. Combination and improvement are sought. In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into better ideas; or how two or more ideas can be joined

7. Ibid., p. 301.
Osborn feels the ideal number for "brainstorming" is between five and ten in a group; although successful sessions have been conducted with many times this number.

Osborn further believes the most difficult panel-members are executives who have been over-trained on the usual kind of non-creative conference.

The writer believes the following instance cited by Osborn emphasizes the point:

"One vice-president of a large corporation told me, after he had gotten into the swing of these idea producing sessions, 'It was hard to get through my head what you were trying to do with us. My fifteen years of conference after conference in my company have conditioned me against shooting wild. Almost all of us officers rate each other on the basis of judgment - we are far more apt to look up to the other fellow if he makes no mistakes than if he suggests a lot of ideas. So I've always kept myself from spouting any suggestions which could be sneered at. I wish our people would feel free to shoot ideas the way we have been doing in these brainstorm sessions'.'

Osborn's Check List of New Ideas - Osborn's suggested use of check-lists for new product conception or improvement can prove very useful.

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8. Ibid., p. 301
9. Ibid., p. 304-305.
10. Ibid., p. 217.
Professor John Arnold of M.I.T. condensed this list into very appropriate form, and the latter is shown as follows:

Check List For New Ideas

**PUT TO OTHER USES?** New ways to use as is? Other uses if modified?

**ADAPT?** What else is like this? What other idea does this suggest? Does past offer parallel? What could I copy? Whom could I emulate?

**MODIFY?** New Twist? Change meaning, color, motion, sound, order, form, shape? Other changes?

**MAGNIFY?** What to add? More time? Greater Frequency?


**MINIFY?** What to subtract? Smaller? Condensed? Miniature?


**SUBSTITUTE?** Who else instead? What else instead? Other ingredient? Other material? Other process?

  - Other power? Other place? Other approach?

  - Other tone of voice?


**REVERSE?** Transpose positive and negative? How about opposites? Turn it backward? Turn it upside down? Reverse roles? Change shoes? Turn tables? Turn other cheek?
COMBINE? How about a blend, an alloy, an assortment, an ensemble? Combine units? Combine purposes? Combine appeals? Combine ideas?

There are many examples in our every day life which exemplify the thinking suggested by the above check list. Take the original mechanical eggbeater and follow through its evolution to the current Sunbeam Mixmaster with attachments, for instance. Through its evolution there are examples of every major category listed in the above check list. The hand power mechanical eggbeater progressed to the present electrical powered mixer with the following attachments and streamlined design:

1. Food chopper with or without an auxiliary power unit.
2. Orange Juice Squeezer.
4. Food slicer and shredder.
5. Butter Churn Attachment.

Through the use of such a check list, one will undoubtedly discover many of his ideas have already been tried—some successfully, some not. Many times success or failure has depended upon not the idea itself but upon its promotion and pricing. But then promotion and pricing are fields in themselves and do not fall within the scope of this thesis. The writer merely mentions this point to bring out the suggestion that a fresh, creative approach to a seemingly good...
idea, that has proved a "flop" on the public market, may prove the idea and thinking behind it sound, and attribute its failure to gain public acceptance to a marketing operation.

Professor Mason Smith, Vice-President in charge of Finance for Whirlpool Corporation, gave such an example to the Sloan Fellows at M.I.T. in a lecture on marketing and pricing. It seems a certain manufacturer devised an electric knife sharpener and decided to market the item himself. The venture proved a failure— from sales figures it appeared the public was not interested in an electric knife sharpener for $9.95. Now it so happened that a certain merchandiser purchased one of these knife sharpeners, liked it, and contacted the manufacturer. The manufacturer related how he had lost money on the entire operation; whereupon the merchandiser offered to contract for 100,000 of the sharpeners provided he had exclusive rights to the entire marketing operation. The manufacturer pointed out he could not afford a price reduction. The merchandiser replied that he was not going to reduce the retail price—he was going to raise it to $14.95. The increased price could provide the needed dollars for "right" promotion, and at the same time, place the product in the "gift-speciality" class. In the latter class, $14.95 could be considered an appropriate amount to spend for a wedding present and the like, where $9.95 would be considered too "cheap" by many. The entire operation has proven successful. Here, then, is an example of how the creative thinking
of two people when coupled together provided a successful operation - where without the second creative approach, the first creative undertaking was doomed to failure.

The history of progress in research provides countless illustrations of how "extending lists of ideas" or "magnifying" the problem have brought creative success to the investigator.

Take the case of Elman, an experimenter of the Bell Telephone Laboratories. L. W. Rapeer, in one of his books, describes the incident quite well.

Every experimenter at one time knew that pure, soft iron was more magnetic than iron alloyed with other magnetic metals such as nickel. Telephones, telegraph, and electric appliances used nearly exclusively Swedish and Norwegian iron. It soon became discouragingly evident that the best imported iron was not permeable enough for best results through submarine cables and the like.

Elman listed the permeabilities of different metals; however, he "extended" or "magnified" it to see what would happen when a small percentage of nickel was added to pure iron. He duplicated the negative results of previous investigators. He kept increasing the amount of nickel until he reached a 20% alloy - the permeability still decreased. Most men would have stopped here - but not Elman. He continued to add nickel, until at a 25% alloy, the curve of permeability or conduction began to rise, suddenly. At a 40% alloy, he found the permeability five times better than pure iron. How
many investigators would have stopped here? Elman was not easily satisfied - he kept adding nickel but no further improvement resulted. He had evidently reached a plateau or leveling off of permeability. Most investigators might well have stopped here. Elman did not. He labored until he found his maximum at 78.5% nickel, 21.5% iron. Here the alloy conducted thirty times better than the costly pure iron which for decades had been supposed to be the best conductor of electricity. Elman had magnified his problem - he had given it the real "third degree".12

There is still the possibility that some young engineer or technician may come along with other metals in other combinations and find a still better conductor by "extending the list of ideas" or "magnifying" the problem.

Crawford's Attribute Listing - Professor Robert Crawford of the University of Nebraska developed and taught for many years a technique that accomplishes results similar to Osborn's "check-list", but does so by quite a different path.13

Briefly the procedure consists of listing the essential qualities or attributes of a particular product or part that is the object of improvement and then, one by one or in groups modifying the attributes to accomplish their purpose in a better, more efficient, cheaper, or more expensive manner.

In the latter case improvements would have to appear to outweigh the disadvantage of increased cost.

A simple example of Crawford's listing can be illustrated using the now old-fashioned wooden handled screw driver. The attributes are listed below:

1. Round steel shank.
2. Wooden riveted handle.
3. Wedge-shaped end for engaging the slot in the screw.
4. Manually operated.
5. Torque provided by twisting action.

The above attributes have been altered many times - not all at once. Every alteration supposedly created a new and better screw driver. (The Honorable Mr. Pike, Assistant Secretary of Defense in charge of Logistics, related to the Sloan Group in December 1954, that in streamlining the Air Force procurement lists, he was confronted with listing of 487 different screw drivers). For example, round shanks were changed to hex shanks to accommodate wrenches; tips were modified to fit all varieties of screw heads and bolt heads; plastic handles have replaced wooden handles to reduce breakage and electrical shock; and the "Yankee" screw driver provides torque by pushing, while electrical power has been substituted for manual power in some instances.

The success of Crawford's technique is sometimes lowered by "familiarity". Many attributes that are "obvious" are overlooked by "experts" or those too familiar with the product. To quote Professor John Arnold:
"I don't believe one has to be an amatuer to innovate, but it may be true that he has to think like one."^14

The General Electric Input-Output Scheme - Mr. L. W. Guth, of General Electric, briefly describes a scheme successfully employed by many in his company in the following manner:

"After making a complete definition, the problem can be broken into three main groups of desired characteristics and requirements. As applied to a dynamic system they may be classified as (1) input, (2) limiting requirements or specifications, and (3) output. A slightly different breakdown might be applied to static systems.

The three groupings may be explained by considering a typical design problem. For example, consider the design of a new type 'noiseless' wall switch. The specifications can be subdivided as follows:

1. Input
   a. Mechanical motion of activating knob.
   b. Only a small force desired to actuate the switch.

2. Limiting requirements.
   a. Must fit into standard outlet box.
   b. 'Noiseless' operation.
   c. Must work satisfactorily and safely with 110 or 220 volts a.c. or d.c.
   d. Cost must be in the range of standard switches.

^14 op.cit., pp. 45-46.
e. Long trouble-free life.
f. Allowable drop across the contacts.
g. Current rating, etc.
h. Appearance.

3. Output
   a. Mechanical movement of contacts.
   b. Required time and motion characteristics to break arc.

"The above is not complete and detailed but serves to show how the groupings can be made. In a relatively simple design as illustrated, complete quantitative data may not be necessary. In general, all dimensions, forces, voltages, etc., should be known quantitatively. If experience has been gained in the field, design sense or 'feel' may give adequate measures, but to depend heavily upon mental extrapolation of past designs quite often results in costly failures." 15

The input-output scheme, though used in the problem statement, can be used effectively for creative approaches.

A Suggestion Plan System

Much has been written concerning Suggestion Plan Systems since the end of World War II. Many systems have succeeded, and some have failed. The writer firmly believes that a system properly conceived and adequately administered encourages creativity from the top to the bottom of any organization. The suggestion plans within the Ford Motor Company have proven

15. Ibid., p. 46.
very successful.

One plan encompasses all non-supervisory employees outside the Engineering Division with a maximum award of $3000. and a minimum of $20. (per award).

A second plan for non-supervisory engineering and scientific personnel (classified non-exempt under Fair Labor Standards Act) includes a $1000. maximum award.

A third plan, known as the Management Proposal Plan is conducted for supervisory and exempt employees with no cash award. In this latter case, commendations are given to those successful idea submitters and the performance is added to their personnel record.

In the year 1954, $748,421. were paid to "Ford Suggesters" across the nation. There were 72,428 acceptable suggestions from which 13,559 awards were paid. There were 15,934 suggestions adopted for trial. 16

In the seven and one-half year history of the plan, a total of 246,172 acceptable suggestions have been submitted. Of these, 64,059 have been adopted for trial and 56,620 have earned awards totaling $2,752,493.17

During the year 1954, there were 35,878 acceptable proposals turned in through the Management Proposal Plan. Of these, 8,574 were adopted for trial and 7,317 commendations were issued. Since this plan was instituted in June, 1949,

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17. Ibid., p. 3.
87,394 acceptable proposals were submitted. Of this number, 26,305 proposals have been adopted for trial, and the number of commendations issued was 19,973.18

There are thousands of other successful suggestions systems in operation in the United States.

The writer believes more companies should introduce some form of non-cash suggestion plan for professional personnel and supervisors. It eliminates the "left-out" feeling; and considerable fanfare can be made of their contributions.

The same can be said for non-supervisory and non-exempt engineering personnel. Here the cash awards can foster ideas and creativity beyond the scope of their immediate jobs. Under this system the supervisor is encouraged to aid his employees in expressing their suggestions, for "stealing" of ideas is reduced to a negligible point, since the supervisor cannot obtain the cash award for himself.

The Philosophy of Recognition - The "everything is all right unless I tell you so" philosophy does not fit with modern principles of effective management. An employee may do a hundred things correctly, but his one mistake gains full attention. Perhaps it is because it is human nature for mistakes to stand out in bold relief that praise and recognition are not given more frequently.

More modern effective management philosophies voice the "accentuate the positive" attitude, where it is believed that

18. Ibid., p. 3.
one must be generous toward giving full credit and recognition to the person who has earned it. It is foolhardy to believe that one loses credit by giving full credit to those under his supervision who have contributed greatly to the overall effort.

Recognition may take many forms, but it is one of the greatest stimulants for renewed effort and greater creative achievement. Failure to recognize easily destroys moral and does violence to the creative process.

Recognition effectively administered becomes a challenge to the employee. He will feel complimented to know his work is recognized by the customer; by the business enterprise; by his fellow employees; by his family; by his supervisor; and by his community.

An effective management policy must have as one of its objectives, a sound philosophy of recognition. It is believed that a sound philosophy of recognition should in turn contain the following principles and objectives:

1. Effective job classifications with realistic titles.
2. Salary and reward policy based on individual contribution to the overall effort.
3. A realistic policy of promotion.
4. Plenty of encouragement and assistance.
5. Exercising "empathy".

The discussion of the aforementioned principles and objectives will concern primarily professional employees and those aspiring to achieve the professional status on the staffs
of our modern research and engineering facilities.

(1) Effective Job Classifications with Realistic Titles

As previously stated our technology has advanced rapidly in the last decade and created entirely new fields of research and broadened existing ones. The new and broadened fields of research have brought into the business enterprise countless specialists, professional and technical experts.

One cannot simply divide the human compliment of our research and engineering facilities into management and labor. Such a "black and white" classification has grown rapidly out of date.

Peter Drucker believes there is no such thing as labor, that is, human beings considered as a purely material, if not inanimate, resource. He believes that labor should be viewed as animate, capable of assuming responsibility and decision making power, and that one ultimate goal of management should be the realization of managerial vision for all members of the enterprise. 19

It would seem more realistic to state that everyone in the business enterprise is a worker, and that every worker performs a kind of work. Management itself is a kind of work with particular traits of its own. Other workers perform skilled or unskilled, manual or clerical type work. The professional or individual contributor performs a specialized type work. It is this last group with which we are primarily

19. op.cit.
concerned. Again the lines are not well defined (as black and white) in this latter group. It is only reasonable to assume that some professional people may border on non-professional; others may border managers; and some non-professional workers (i.e. technicians) may border professional. Taking all these variations into account, the entire group still poses a problem of its own.

Many business enterprises have failed to adequately describe, classify, evaluate, and title the professional work being carried on throughout their facilities. It is the writer's contention that this situation is responsible for some discontentment and is a counter-stimulant to creative thinking.

To use an actual example, the Ford Motor Engineering Research Department (from the writer's experience) classifies its technical personnel into Research Engineer Senior, A and B; Product Engineering Designer Senior, A and B; and Research Technician Senior, A and B.

Of these classifications, only those of the Research Engineer, the Senior Product Engineering Designer, and Senior Research Technician are considered professional. Brushing aside any argument as to whether the non-professional classifications stated above might in part be considered professional, the job descriptions and classifications are given only in the broadest terms.

A Research Engineer Senior, A or B might constitute anyone of the following, and the list is by no means complete:
Engine Engineer
Carburation Engineer
Fuel Engineer
Combustion Chamber Engineer
Wind Tunnel Engineer
Spring Engineer
Metallurgical Engineer
Sound and Vibration Engineer
Stress Analysis Engineer
Photo-elasticity Engineer
Photographic Engineer
Electrical Engineer
Electronics Engineer
Chassis Engineer
Suspension Engineer
Brake Engineer
Ride Engineer
Hydraulic Engineer
Thermodynamics Engineer
Computer Engineer
Mathematician
Lubricant Engineer
Physical Test Engineer
Physicist

An accurate job description, classification, and title more in keeping with the actual work being done by the professional should go a long way toward establishing individual
recognition within the enterprise, and, at the same time, more clearly symbolize the value and prestige the company places on the contribution of the professional.

The more accurate job titles (displayed wherever possible) could coincide more with those of management and carry weight and prestige.

The professional employee enjoying professional recognition could have a more potent incentive to keep abreast of his field and increase his proficiency and creative output.

Dr. I. F. Kinnard, Manager-Engineering (Director) of the General Electric Measurements Laboratory, Lynn, Mass., related to the writer in an interview that General Electric felt very strongly on the subject of displayed and realistic job titles for their professional personnel. Dr. Kinnard and Dr. A. Hansen (Manager of Advance Engineering) both felt this type recognition of professional personnel stimulated creativity. While touring the laboratory facilities, nearly a hundred such titles were displayed in the hallway outside the various laboratories.

(2) Salary and Reward Policy Based on Individual Contribution to the Overall Effort

It is believed that a salary and reward policy based on individual contribution to the overall effort is an important factor that stimulates directly the creative output of professional personnel.

There is no intention to here discuss the many details of wage and salary policy and its administration. Rather, it
is intended to broadly outline an objective policy bringing into play the views of several executives interviewed and the opinions of the writer from his personal experience as a professional employee and as a manager of professional employees.

A good salary and reward policy should contain three objectives:

a. An adequate salary range through which to progress within a given job classification.

b. An adequate range of job classifications progressing to the point of profit sharing without, necessarily, management administrative responsibilities.

c. Salary and reward should be based on individual contribution to the overall effort.

Again as an example, the Engineering Research Department of the Ford Motor Company will be used to amplify the objectives cited. The following monthly salary ranges and classifications (though subject to change under the "annual improvement factor") existed approximately as shown for a Research Engineer:

Research Engineer "B" - $325 - $525.
Research Engineer "A" - $425 - $650.
Research Engineer "Senior" - $525 - $800.

The first objective, concerning an adequate salary range within a given job classification, is important because the latter allows a man to progress within his classification, through merit salary increases, over a period of time sufficient to acquire additional maturity and experience; and at
the same time prove himself through individual contribution in a manner that will qualify his passing to the next higher classification.

There is a range in each classification varying from $200. to $275. per month. A man may progress through merit raises within each classification to the extent of 15% of base salary in any one year. The movement from one classification to the next higher one constitutes a promotion and can carry a maximum increase of 15% of base salary in addition to the 15% maximum merit raise.

The maximum and minimum salaries for each range overlap and make it possible for a man in the Research Engineer B classification to earn a maximum salary nearly equal to the average for the next highest classification and as much as the minimum salary for the job classification beyond that. Such an arrangement takes some of the overemphasis away from promotion, and places emphasis on extraordinary performance on the job.

Concerning the second objective it is believed that upgrading job classifications should be provided for in such a manner that a young engineer (for example), hired at the completion of his college career, can work from his original "hire-in-classification" through to a profit sharing plan, without necessarily having to become a supervisor or incurring administrative responsibilities during his service life with the company.

It is not meant to imply that all professional employees
reach the profit sharing plan. Neither do they progress within or through job classifications at the same rate necessarily. Their progress should be based on accomplishment or individual contribution to the overall effort - this then is the third objective.

Through the three objectives cited, it therefore becomes possible for the deserving professional employee to earn a very respectable salary - comparable to, and in many cases greater than, some members of management.

It is believed that too many writers of organization, management, and creativity do not attach proper weight to the salary and reward (or prospect of reward) as a primary force acting upon professional or pre-professional employees to encourage and stimulate creativity and performance beyond the ordinary requirements of their jobs.

It is further believed that considerable frustration is removed from the minds of this group, when it is pointed out to them (and also carried through) that there is a clear road ahead, with no "blind alleys" or "forgotten corners", over which they can progress to achieve their due reward, prestige, or recognition, based on their individual contribution to the overall effort.

Peter Drucker has stated in his latest book:

"Pay incentives for the professional employee are largely tied today to promotion into administrative positions. But pay should always focus on a man's contribution to the business. And we must recognize that a man can make fully as
great a contribution to the business in the role of professional contributor as he can make in the role of manager."

Dr. I. F. Kinnard, Manager (Director)-Engineering, of the General Electric Measurements Laboratory, Lynn, Mass., related to the writer in an interview that he believed one of the most important factors fostering creativity was a salary schedule that recognized the role of the individual professional contributor. He pointed out various people whose salaries were higher than those of many of his administrators and indicated through charts, evaluating individual contribution, why this was so. It was also mentioned that for every patent applied for, the inventor was awarded one share of General Electric stock.

(3) A Realistic Policy of Promotion

Peter Drucker commented in his latest book:

"The best professional employee rarely makes a good administrator. It is not that he normally prefers to work alone, but that he is bored, if not annoyed, by administration. The good professional employee has also little respect for the administrator. He respects the man who is better professionally than he is himself. To promote the good professional employee into an administrative position will only too often destroy a good professional without producing a good manager. To promote only the good administrator - who more often than not will not be the outstanding professional in

20. Ibid., p. 336.
the group - will appear to the professional employee as irrational, as favoritism or as reward for mediocrity. Yet, so long as business has no promotional opportunities except into administrative positions, it will be confined to choosing between these two evils."

It is believed, though some of Drucker's words are rather strong in the preceding paragraph, that basically his proposition is sound. The case of expanded and more accurate job titles has already been made. Emphasis can be placed on these job titles to provide the promotional opportunities that carry the same weight and prestige as the traditional opportunities for promotion to managerial positions.

A pre-requisite to a realistic promotional policy involves the hiring of a professional into a given group. It is an important proposition that he be placed in a job classification that will allow him sufficient salary range through which to progress without forcing premature promotion. If this proposition is not observed, the supervisor or manager may find himself faced with the problem of promotion in order to give a merit raise, within the first year of the new employee's service.

This situation can have undesirable consequences all the way around. If the supervisor chooses the alternative where the merit increase and automatic promotion are both proposed and granted, the employee may get the mis-directed idea that

21. Ibid., p. 335.
promotions are easily obtainable. In addition, other employees through longer service and greater contribution, may be more deserving of the promotion - in which case, ill feeling and general discontent become evident.

If the supervisor chooses or is forced to choose the opposite alternative (where for example the merit raise could have been approved but not the promotion), the employee rests in a blind alley; for a merit raise, of an amount that would not be insulting to him, could not be given without automatically placing him in a higher classification. In this situation, the employee is bound to be discouraged; and a promise of future review of his predicament accomplishes little.

The remarks that have been made thus far do not preclude the probability that many professional employees are good managerial material.

Promotion should be based on proven performance. Nothing creates greater havoc among the creative forces of a group than the often, common practice of promoting a poor man to get rid of him, or denying a good man promotion because "we don't know what we'd do without him".

A realistic policy of promotion must insure that everyone who is eligible is considered and not just merely those in the "limelight". Too often business enterprises have lopsided promotional opportunities that reflect little but confused objectives, mental laziness, the dead hand of tradition and promotion by any standard but proven competence.

If a man can be fired or demoted for poor performance,
he must also be eligible for reward and promotion for extraordinary performance. Men who regard their jobs from the viewpoint of security are not likely to accomplish much from the creative standpoint, that is, to pioneer, to innovate, or strike out for the really new.

Within an organization, a majority of people are rarely being promoted. Promotion, therefore, should not be overemphasized for it can conjure frustration and demoralization among those not promoted, or foster the wrong kind of competitive spirit, where people attempt to progress at the expense of their fellow-employees.

Management must carefully regard those they desire to promote, whether from the professional ranks or their own ranks. It cannot build team spirit and encourage the creative output of its people by adoption of the philosophy, "do as I say, not as I do". All the management philosophies and practices in the world mean absolutely nothing, if management does not have the integrity of character to "practice what it preaches" - this after all is the final proof. Professional employees and others alike are quick to ascertain whether or not their associates (or superiors) have integrity. They can forgive a man for ignorance or incompetence, but not for lack of integrity - and the same applies to management if they choose such a man for promotion.

Peter Drucker has emphasized this viewpoint in the following manner:

"A man might himself know too little, perform poorly,
lack judgment and ability, and yet not do damage as a manager. But if lacking character and integrity - no matter how knowledgable, how brilliant, how successful - he destroys. He destroys people, the most valuable resource of the enterprise. He destroys spirit. And he destroys performance."

The writer would like to add - "And he destroys creativity - Amen!"

Idealistic as it may sound, management cannot afford to appoint anyone to a management position whose character cannot stand the test of that of a model.

A good manager should possess the leadership and those inspiring qualities that cause other men to "produce creatively" beyond the ordinary requirements of their jobs.

Appraisal of a good man or manager is a matter of judgment. Judgment must be made to some standard - something tangible - not mere "good personality" or "good promise or potential".

What has a man done? What has he accomplished?

A man can achieve by doing. Appraisal can start here. If we know a man's strong points, we are in better position to evaluate his weaknesses and then attempt to strengthen them.

What can then be done about "safe mediocrity". How can professional employees (or others for that matter) be encouraged to work creatively and produce beyond the ordinary re-

22. Ibid., p. 158.
quirements of their jobs when they are harnessed by a "boss" or "a management" that believes in "playing it safe"? The attitude discourages the trying of anything new; the risking of a mistake, the building of a "fighting team spirit"; or a feeling of security. Security must be founded on solid high performance, objectives, accompanying recognition, and the knowledge that a mistake does not constitute "suicide".

If then, consistent rendering of poor performance or mediocrity in management cannot be tolerated within an organization because of its inhibiting aspects to creativity and high performance - what then must be the fate of the mediocre manager?

Promote him?
Transfer him?
Demote him?
Fire him?

Before selecting a course of action, management must first settle its own conscience.

Case I - Does the manager perform poorly in a job to which he was promoted that has proven to be beyond his capacity?

If this is the case, the manager is not entirely to blame, and management has an obligation to him because of his loyal service.

Case II. Does the manager perform poorly because, through the course of time, the job requirements have risen beyond his capacity of training and ability?

If this is so, the manager alone is not to blame.

Case III. - Does the manager perform poorly because he overstated his qualifications and ability at the time he was hired
into his present job? Has he shown lack of integrity in his relationships with superiors and subordinates?

If this is the case, management is not to blame.

Once management has settled its conscience, the writer believes that in none of the stated cases should the manager be retained in his current capacity. This is an obligation of management to the entire company, to its management group spirit, and to those who perform well.

Under no circumstances should the manager be promoted to "get him out of the way". This course of action places a reward on mediocrity in the eyes of the rest of the organization and transfers the handicap to other employees.

In the third case, the manager should be fired, for he has oversold himself and destroys the creative performance and spirit of his people through his lack of integrity.

Neither of the first two cases is entirely "black and white" and where management is partly to blame, great care and consideration must be exercised in each individual case. As previously stated, the manager must be relieved of his immediate responsibilities - but whether or not to fire him is another question. For loyalty and service, a man deserves a careful analysis by management of his true capabilities. Management, through some creative thinking of its own, should be capable of devising a transfer of jobs more in keeping with the man's capacity, for he must be of some value to the enterprise in view of his service life with it.

A realistic policy of promotion then should be based on
high performance standards, high integrity of character for
the individual, and promotional opportunities for profession-
al, non-administrative people, that carry equivalent prestige
 to those of management.

(4) Plenty of encouragement and Assistance

It is believed that management should constantly encour-
age and assist its professional employees toward bettering
themselves, becoming more proficient in their respective
fields (or others if they so desire), and in keeping abreast
of current developments. Proper recognition within the busi-
ness enterprise as an incentive to accomplish these objec-
tives has already been discussed.

Proper recognition outside the enterprise can be accom-
plished by management's encouragement of membership in the
various professional societies. Management could well afford
to pay for the membership of its professional people to these
societies and encourage their presentation of "papers" be-
fore the various groups. Good professional employees are of
such value to the enterprise that management should not only
encourage but reward, in some form, their continuation of ed-
ucation and professional development.

Another proposition that should be considered by manage-
ment is the engagement of their professional employees in
outside teaching (part-time) in universities or similar in-
stitutions of learning. The writer does not merely imply
night school teaching, but also daytime teaching. The ad-
vantages of this proposition are that the professional gains
more prestige and recognition in the community, inside the enterprise and attracts a second generation of professionals to the company - not to mention the added prestige and advertising (subtle) he gives his company in the teaching institution and community.

Dr. A. Hansen, Manager of Advanced Engineering, General Electric Measurements Laboratory, related to the writer that their management believed membership in professional societies and the like were a man's own undertaking and part of his own professional development. They believed in encouraging such participation but not in financing it.

Dr. A. Hansen had strong feelings on the subject of "environment" for stimulating and encouraging creativity. He believed the following characteristics constituted an ideal environment for professional personnel.

1. An "academic atmosphere", neat, quiet, modern and comfortable with few interruptions.

2. Each laboratory unit should have "triangular facilities". "Triangular facilities" can be symbolized through use of an imaginary triangle where at one corner is situated the "idea" man or professional; at the second corner the designer; and at the third corner the fabricator or man who makes the pilot model with proper facilities at his disposal. Along the sides of the triangle communication or "idea penetration" moves in both directions. The supervisor can be visualized as situated in the middle of the
triangle with the same communication or "idea penetration" moving into the center from each corner and back again. More than one person can occupy each corner of the triangle in requirements or demand.

3. A "suite" for each professional man. Instead of seating a number of these people at rows of desks in a single open room, each man is given semi-privacy by placing his desk against the window wall and constructing shoulder-high partitions out from the wall in front of and behind each desk unit, leaving the fourth side open to the aisle. Each unit is approximately six feet in length and contains book shelves on one partition and a filing cabinet between the desk and the forward partition. The degree of privacy offered by this arrangement allows conversation to take place in each unit without disturbing those men adjacent to the unit.

(5) Exercising "Empathy".

"Empathy" is a word that has only recently emerged from the psychological laboratories. It is defined as the ability to appreciate and recognize the other person's feelings without becoming emotionally involved to the extent that one's own judgment is affected.

Empathy is akin to sympathy, but whereas sympathy may

say "I feel as you do", empathy says, "I know how you feel." Rather than using our hearts, empathy enables us to use our heads. By the employment of empathy, one fosters a detached insight which is of far greater help toward overcoming another person's unhappiness.

The meaning of the word is analogous to a mountain climbing party where one member has lost his footing and dangles over a cliff. You can't help by jumping after him, but rather by making your own footing secure enough to haul him back.

Role playing is a means of looking at the problem through the concerned person's eyes.

It is believed that recognizing how the other person thinks and feels can be an effective means of stimulating creativity in professional employees (and all others for that matter).

Dr. Rensis Likert, director of the University of Michigan's Institute for Social Research, says:

"The worker who feels that his boss sees him only as a cog is likely to be a poor producer. But when he feels that his boss is genuinely interested in him - his problems, his future, his well-being - he's more likely to be a high producer." 24

24. Ibid., p. 64.
CHAPTER IV

The Application of the Concepts and Stimuli of Creativity to Professional Personnel

Numerous stimuli of creativity applicable to professional and pre-professional personnel have been suggested and described in Chapter III. Ideas or suggestions are one matter, the actual "doing" or application of these stimuli is another. Management will undoubtedly require some degree of "selling" - to what extent, however, is not readily assessible.

The writer will, therefore, select as a "test area" the Engineering Research Department of the Ford Motor Company. Here department management is fully aware that one of its objectives is to promote the high performance and creative output of its people - for the prime commodity of this department is "saleable, worked-out ideas" for the Engineering Division. Any suggested proposals for increasing the creative efficacy of its people would therefore find eager listeners.

Atmosphere

It will be proposed that the first consideration involve the provision of proper "atmosphere". Here it is believed that an academic atmosphere - neat, quiet, modern and comfortable with few interruptions is conducive to creative thinking and the working-out of ideas.

Current management has experienced the disadvantages of improper atmosphere for the last ten years, having been housed over this period in an old reclaimed building. A completely new building is now under construction and from the writer's knowledge of the plans, the atmosphere should
be improved considerably.

"Triangular facilities", as previously discussed, have been provided in many instances. It is believed, however, certain disadvantages will still exist in the new building. Professional people will be seated at consecutive desks in single open rooms. No manner of privacy is afforded by this arrangement, and the latter from the writer's experience facilitates considerable interruption from adjacent conversation, telephone and the like.

The semi-private atmosphere provided by the construction of shoulder high - six foot long - partitions out from a windowed wall, located in front of and behind each desk, deserves worthwhile attention. Each unit is approximately six feet in length and provides book shelves on one partition wall and a filing cabinet between the desk and the forward partition.

This arrangement as previously pointed out has proven quite satisfactory in the General Electric Measurements Laboratory.

The writer would propose that management consider the construction of a model room to incorporate the above suggestions and any additional proposals and that it be occupied by one of the research units over a given test period. Advantages and disadvantages could be evaluated from group comment after "living" with the arrangement for a period of time.

It is firmly believed that "proper environment" is a dynamic situation, not a static one, and that both management and employee could profit from "research directed toward ob-

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l. Page 78 of thesis.
taining the most desirable atmosphere for high job performance and creative output".

**Realistic Job Titles**

It has been previously pointed out\(^2\) that our technology has advanced rapidly in the last decade and created entirely new fields of research and broadened existing ones. These new and broadened fields of research have brought into the business enterprise countless professional and technical experts who perform a specialized type work either as individual contributors, as a group, or both. This group has posed a problem to management concerning their proper placement within the organizational structure\(^3\) of the enterprise, not to mention that considerable confusion exists as to just what to call these professional employees. General Electric calls them "individual contributors" for lack of better terminology - and the latter does not really suffice.

As previously discussed\(^4\), the job classifications and titles of the Research Engineer in the Engineering Research Department of the Ford Motor Company are considered professional and are broken down into the classifications and titles of Research Engineer Senior, A and B. The job classification of Senior, A and B may be satisfactory, but it is the writer's contention that the job title **Research Engineer**

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fails completely to identify the professional with the kind of work or speciality in which he is engaged. An incomplete list of twenty-four different engineers or specialists has been given as existent in the Engineering Research Department at Ford, and they are all titled Research Engineer.

It is believed, therefore, that new job titles such as Chassis Research Engineer A, Senior Hydraulic Research Engineer, and Electronics Research Engineer B, should be instituted. Job titles more in keeping with the actual work being done by the professional should go a long way toward establishing individual recognition within the enterprise, and, at the same time more clearly symbolize the value and prestige the company places on the contribution of the professional.

It would also be proposed that similar revision be accomplished for the classifications of the research technicians and designers.

Outside each laboratory or unit room, a list of the names and titles of the occupants could be posted. In the cases of those employees whose job titles were below the senior level, the A or B portion of the classification would not appear for obvious reasons - i.e. merely, John Jones - Chassis Designer, or Roy Smith - Engine Research Engineer.

More realistic job titles would in turn coincide more with those of management and carry added weight and prestige.

The professional employee enjoying professional recognition has a more potent incentive to keep abreast of his

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field and increase his proficiency and creative output. The same can be said of non-professional employees.

To the writer's way of thinking, another change should be instigated in the realm of management titles. Specifically, the advocated change involves the word "supervisor". Organizationally, departments are broken down into sections and units and their respective heads are known as Section Supervisors and Unit Supervisors in Ford Engineering Research.

The word or term "supervisor" describes just the opposite of what the job really constitutes. It is generally believed the term is an outgrowth of the word "foreman" - of "gang leader" concept. Today's management at this level do not really supervise - they manage. They set up objectives for men, they hire them (most non-production jobs), they train them, they schedule and plan work - this is management. The management titles mentioned above could well be re-named - Section-Manager and Unit Manager. IBM has gone to this concept and General Electric is considering it.

Salary and Reward Policy

A policy of adequate salary and reward has been discussed at length, and it is felt that Ford Engineering Research meets the requirement of such a policy. Again it should be emphasized that a salary and reward policy based on individual contribution to the overall effort is most necessary to stimulate directly the creative output and high

performance of professional personnel. Such a policy must meet three objectives:

1. An adequate salary range through which to progress within a given job classification.

2. An adequate range of job classifications progressing to the point of profit sharing (or similar reward) without, necessarily, management administrative responsibilities.

3. Salary and reward should be based on individual contribution to the overall effort.

Through the three objectives cited, it therefore becomes possible for the deserving professional employee to earn a very respectable salary - with additional reward - comparable to, and in many cases greater than, some members of management.

The writer is firmly convinced that considerable frustration is removed from the minds of professional employees when it can be pointed out to them (and carried through by management) that there is a clear road ahead, with no "blind alleys", or "forgotten corners", over which they can progress to achieve their due reward, prestige, and recognition, based on their individual contribution to the overall effort.

Realistic Promotional Policy

In the writer's opinion, management will be confined to choosing between two evils so long as there are no promotional opportunities except into administrative positions. The good professional employee does not necessarily make a good
administrator - the company loses both ways here - it loses the creative output of a good professional and inherits a mediocre or poor manager. If the company promotes only the good administrator (usually not the good professional), the professional cries, "Favoritism", or "Reward for mediocrity". This is the principal reason for the writer stressing the point of "realistic job titles" and promotional opportunities within the "professional classifications" - these can carry the same weight and prestige as the traditional opportunities for promotion to managerial positions.

It should be a cardinal point with management that promotion be based on proven performance. Nothing creates greater havoc among the creative forces of a group than the often, common practice of promoting a poor man to get rid of him, or denying a good man promotion because "we don't know what we'd do without him".

Management must carefully regard those they desire to promote, whether from the professional ranks or their own ranks; for a good manager should possess the leadership, integrity, and inspiring qualities that cause other men to produce creatively beyond the ordinary requirements of their jobs.

Mediocrity as previously discussed cannot be tolerated in management. The mediocre manager must be relieved of his responsibilities for this is the obligation of management to the entire company, to management group spirit, and to those

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in both management and non-management jobs who perform well.

From the writer's point of view, little can be accomplished along the lines of the concepts discussed in higher echelons where decisions are beyond control. If the concepts are practiced at the writer's level and voiced often enough to higher levels perhaps good will come of it. True spirit is created at the top - but organizational spirit like trees, dies from the top.

Creative Techniques

Within the Engineering Research Department at Ford, many creative projects are attacked through employment of the technical resources of several groups of specialists. The writer believes this is fruitful ground upon which to try "Osborn's Brainstorming Technique", "Check-List of New Ideas", "Crawford's Attribute Listing".

The writer intends to chairman several "brain-storming sessions" until others obtain the knack and experience. If the first several sessions can be proven fruitful, the results should travel fast. Others can conduct similar sessions and through proper publicity the technique should spread rapidly.

The "Check List of New Ideas" and "Crawford's Attribute Listing" can be printed and copies passed on to all department personnel and management.

Prior to the passing out of such information, the writer could brief the department management on the thought and

substance of the material.

A Book of Future Projects

Professor John Arnold of M.I.T. posed the following question to the writer, "Why not, in a Research Department for example, develop a book of future projects 'thought up' by really letting your imagination run wild?"

It is believed there is considerable merit to this suggestion. Projects within the Engineering Research Department of Ford Motor are usually, with some exceptions, five to eight years from becoming a reality in the production vehicle. Although ideas developed under Professor Arnold's proposal might seem completely ridiculous and impractical at the time, at the rate our technology is developing, their possibility of becoming a reality might surprise even the most pessimistic. Through the process of "incubation" additions can be made to the submitted ideas from time to time as a result of frequent consideration or mulling over by the conscious or sub-conscious mind.

The writer intends to follow through with this suggestion.

Encouragement and Assistance

It would be wise for management to constantly encourage and assist its professional employees (and non-professional for that matter) toward bettering themselves, becoming more proficient in their respective fields (or others if they so desire), and in keeping abreast of current developments. This subject has already been covered in some detail; however
Engineering Division management has for some years been toy-
ing with the supplementary educational program along college
or post-college lines.

Interest in such a program runs high among professional
and non-professional employees within the division according
to questionnaire results. Similar programs are being con-
ducted by other companies in conjunction with nearby univer-
sities and colleges.

The advantage of conducting such a program through an
educational institution involves the desirable proposition
of obtaining college degrees.

It is believed that if adequate pressure is applied to
management, perhaps the desire for additional education can
become a reality.

Good professional employees are of such value to the
enterprise that management should not only encourage but re-
ward, in some form, their continuation of education and pro-
fessional development.

Conclusions

Today's management must recognize the role of the professional employee engaged in creative pursuits in the research facilities of the modern business enterprise. Though many creative results are achieved through team effort, great ideas are still by in large the product of a single mind. Management must recognize that a man can make as great a contribution to the business in the role of a professional or individual contributor as he can make in the role of a manager or administrator. A management policy in keeping with the aforementioned proposition should contain the following objectives:

1. Realistic job titles more in keeping with the actual work being done by the professional that would in turn coincide more with those of management and carry added weight and prestige.

2. A salary and reward policy based on individual contribution to the overall effort and progressing to the point of profit sharing (or other similar "extra" reward) without, necessarily, having to assume management administrative responsibilities.

3. A promotional policy based on proven performance and containing promotional opportunities within the professional job classifications (with titles) that carry the same weight and prestige as the traditional opportunities for promotion to managerial positions.

4. Management, as a further extension of its promotional policy, must carefully regard those they desire to pro-
mote - for whether from their own ranks or those of the professional a good manager should possess the leadership, integrity, and inspiring qualities that cause other men to produce creatively beyond the ordinary requirements of their jobs.

5. It is the obligation of management to the entire company, to its own group spirit, and to those in both management and non-management jobs who perform well, that "mediocrity" in management not be tolerated.

6. A continuing research policy on the part of management directed toward obtaining the most desirable atmosphere for high job performance and creative output.

7. Management must constantly encourage and assist its professional employees (and non-professional for that matter) toward bettering themselves, becoming more proficient in their respective fields or others, and in keeping abreast of current developments.
BIBLIOGRAPHY

BOOKS


8. Easton, William H., Creative Thinking and How to Develop It, New York, American Society of Mechanical Engineers, August, 1946.


BIBLIOGRAPHY (cont.)

BOOKS (cont.)


MAGAZINES


MONTHLY NEWSPAPER