

## The Power of Concept

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### Introduction

*The power of concept* is so immense that undertaking to discuss it brings on a feeling of personal inadequacy and of battering at an impenetrable barrier. It is not that readers are intellectually deficient, nor that I have no words directly to the point, but that words, even illustrated by graphs and pictures, are such dull tools of communication that we, as individuals, are almost completely isolated one from the other.

What one word means exactly the same to any two of us?

In the unabridged dictionary "one" itself has 17 definitions.

Complete understanding of one another is actually impossible.

If, therefore, some of the following statements appear dogmatic or demagogic sentimentality, they are not so intended. They are merely awkward words beating at the barrier between us, probing for a crack through which to reach your curiosity, or your desire to understand, and cause you to think deeply of, not merely consider, the subject; for understanding is something no one can give another. It is something *each one* must *achieve* for himself.

With this in mind let us ask: Which one of us has done a *single thing that absolutely no one else* could have done? And how long has it been since each of us fairly burned to be turned loose to do, not one, but a dozen such wonders?

### How Long Has it Been?

How long since we read *Ivanhoe*, *Deerslayer*, *Tom Sawyer*, *Tom Swift* and *Tarzan of the Apes*, in our imaginations living through unbelievable feats with the young, resourceful character of the moment? In that moment each of us became what we most wanted to be—an individual, unique and distinct from every other individual, and doing something no other individual ever created could do.

Yet today practically all adult Americans settle down to a bread and butter job—practically the same day after day—a job dozens and probably thousands could do just as well. They settle down to sleeping, waking, bathing, and eating with all the mental vigor of a contented cow. Perhaps they show they're "on the ball" at work when the

boss is near—but really they do not feel vigorous at all. Vacant minded they ride home to eat and deaden their imagination by rattling a newspaper or watching television until bed time, then dozing off after a day of avoidance of thought only to wake in the dark—to think fitfully of dozens of troubles which never actually happen.

Why have most of us thus failed to reach the goal of unique individual achievement our imaginations once assured us would be ours? Someone asks, "What imagination?"

Both are questions for each individual to ask himself. Perhaps in the search he can find a key to the renewal of that wonderful experience, the play of curiosity and personal originality, which was such a constant thrill to most of us as we grew up—and after going to school and getting a job, found we had lost.

### What Is Power?

In this search for our lost curiosity and personal originality it may be helpful to consider imaginatively the *power of concept*, the power of thought.

What is *power*? You say, "What a silly question to ask engineers."

But what *is power*?

Is it that product of an electrical impulse? That result of burning mixed gases in a closed compartment? That something-or-other we cannot define, embodied in a man sitting upon a throne with a crown on his head? Is *power* hard or soft to the touch? What does it taste like? Look like? Describe its smell—onion, garlic, attar of roses? Can we isolate it in a test tube? Can we pump it like a gas into a container and store it under pressure?

About as near as we can get is: *power* is that which appears to make something happen.

Is *that* which makes something happen an object, a thing? Obviously not. It is not a thing. Is it, therefore, a figment of imagination? That is hard to accept for we can nearly experience *power*, the *not* thing, by observing the *something* it apparently causes to happen.

So, in attempting to define *power* we have arrived at a *concept* of it; we have illustrated the meaning of the other term of our title. A composer of note defines *concept* as a "vision of the whole".

And if we are to think uniquely as individuals we must neither fear nor scorn to use the word "vision", The Apostle Paul saw a great vision and many other lesser ones—and the world is profoundly changed, no matter

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how you explain what he called a vision. This power of a vision to change the world and all that is in it is what we mean by the *power of concept*.

The *power* of scientific *concepts* or visions of the whole is of particular interest to the engineer or scientist.

### Are Concepts Always Creative?

Among the earliest physical researches carried on were those on weather. Some of the original observers noted that frogs croaked gleefully during a rain. So there was derived the *concept* that the croaking of frogs caused the rain, and men thereafter dressed themselves like frogs and hopped about croaking in a lively fashion to make it rain.<sup>1</sup>

If the power of that *concept* did not produce the coveted abundant crops, it did characterize the early imaginative *concepts* of savages—their visions of controlling their natural environment and their gods by imitation, cajolery, sacrifices, trickery or alibi.

The *power* of these *concepts* kept the world and its people in a turmoil for thousands of years, first with their witches, ghosts and evil spirits and later with wholesale strife and persecutions such as the New England witchcraft executions. Yet with all their bitter fruits the power of these superstitious *concepts* accomplished a tremendous innovation which we like to believe was an advance. These concepts freed forever the minds of men from the dependence upon animal instincts and made possible the *concept* that men are reasoning creatures.

Today we hold the *concept*, that vision of the whole, that we can control our natural environment and discover and appropriate for ourselves all the hidden and mysterious powers of the universe by *reason*. Let us note briefly the *power* of this *concept*.

F. A. Hayek in *The Counter-Revolution of Science* writes, "And never can pride in the achievements of the natural sciences and confidence in the omnipotence of their methods have been more justified than at the turn of the eighteenth and nineteenth centuries, and nowhere more so than at Paris where almost all the great scientists of the age congregated."<sup>2</sup> Thus, it came to be that the Goddess of Reason sat enthroned over the Revolution in France whose grand design was to remake not merely France but the whole world.

Out of the *power* of this *concept* flowed the French Revolution and the Napoleonic wars which devastated Europe and created nations of individuals with warped, hating minds. From this same philosophic or conceptual course came our war between the states with its half-million dead from a population of 30 million, and from these same conceptual fields, plowed by shot and shell for a hundred years, grew World Wars I and II and world communism.

Today, under the *power* of the *concept* that men are reasoning creatures, we have reached the point that a citizen in our civilization controls less of his own time than in any past civilization and is less free to move about the world than in any other time in history.

The *power* of this *concept*, today, gives us even the ability to sit and watch civilization, as we know it, deteriorate.

The included illustrations (Figs. 1, 2 and 3) tend to support this statement. Time is short to talk of them in detail. Let us say, merely, that their peaks correlate well with specific event patterns in the countries indicated and

the correlation is well worth a person's deepest thought. Fig. 1 indicates that in France, Germany and England the trend of innovation was downward even before 1900. In the U. S. it was still upward. Even here, though, the trend of fundamental inventions was downward; and Fig. 2, based on information not completely comparable, shows patent issues have declined markedly since 1932. Since then, engineering man power and research funds have increased in some nonlinear fashion while the gap, widened continuously between per worker assets in this country and what the worker produced (Gross National Product). Fig. 3 spells this out by correlating the well-known man-hour productivity index with our reproducible assets to discover the trend of output per man-hour *per billion dollars of assets*. The highest point is in the early 1940's and actually we now appear to be doing no better a producing job than we did 40 years ago in 1920.

There appears to be little question of the *power* of the *concept* that men are reasoning creatures; but there is a big question on why it has actually caused more misery in less than 200 years than the imaginative faculties of the mind produced by superstitions in perhaps 10,000 years.

### What Are Our Conceptual Traps?

The answer appears to be wrapped up in one word, "overconfidence". Operating a human mind is somewhat like operating an automobile. As long as we stay a little afraid of it we seldom get hurt.

How long has it been since each of us made a grave mental error in a *simple* matter such as correlating cause and effect—just as did the savages who believed the croaking of frogs caused rain rather than that rain caused frogs to croak?

Writing over 200 years ago of a man's having certain experiences repeated often enough to label them "cause and effect," David Hume said:

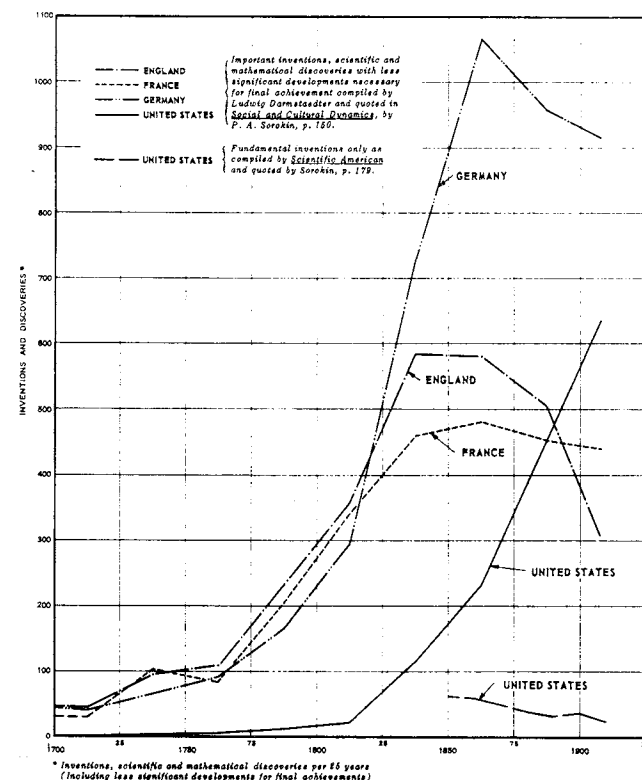


Fig. 1—Important discoveries and inventions (1700-1908).

<sup>1</sup>References given at end of paper.

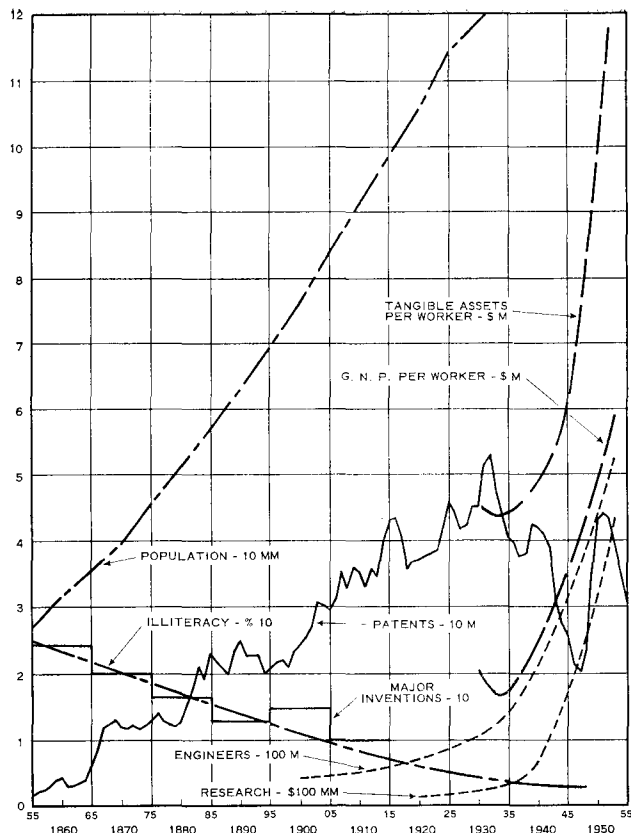


Fig. 2—Some factors in the growth of U. S. industry.

... Yet he has not, by all his experience, acquired any idea or knowledge of the secret power by which the one object produces the other; nor is it, by any process of reasoning, he is engaged to draw this inference. But still he finds himself determined to draw it; And though he should be convinced that his understanding has no part in the operation, he would nevertheless continue in the same course of thinking. There is some other principle which determines him to form such a conclusion.

This principle is *custom or habit* . . . All inferences from experience (cause and effect), therefore, are effects of custom, not of reasoning.<sup>3</sup>

Does Hume then advocate disregard for experience, custom and habit? Not at all—merely that we be a little afraid of them and not be misled by their apparent conclusiveness.

Another popular *concept* powerful to produce grave mental error is the idea that human senses tell the mind the truth from their actual contacts with reality—which is a state of existence as it actually is. This occurs despite the fact that men's senses have many times told different stories of the same reality. Over here what was red to almost everyone was green to a few; and there, a combination of sounds which rang beautiful and true to one man fell upon the tone-deaf ears of another.

Popular *concepts* of scientific instruments were the next booby trap for human experience as men surrendered to *reason's* growing reputation of infallibility. The Newtonian eye, unaided, it is said, observed the apple fall—a sensual experience. But when that eye sought to probe the heavens, the Newtonian mind had to devise the reflecting telescope to go between the eye and the reality it strained to see immeasurably out in Newton's infinity. Literally and figuratively, it was a mirror which reflected an image of the reality far beyond mere human ken. So it is that all scientific instruments merely mirror the image of reality they were designed to apprehend and instrument distortions of that image are not easily perceived nor precisely corrected.

Still another trap in the *concept* of reason's infallibility lies in communication—our fond fancy that by language we can convey reality—the state of existence as it actually is—when that reality is already distorted by the double errors of the observer's senses and of scientific instruments. Words often merely add a third distortion.

As an attempt to clarify some of the difficulties of communication, we resort to the mathematical formula. This actually is to impose a blank wall between sensual experience and reality—that which is—and place understanding on a completely intangible plane. We feel that we experience, in some physical fashion, the story of our senses, of scientific instruments and to a lesser extent the story of worded communication; but the human being simply cannot sensibly experience a mathematical formula.

The fallibilities of the popular *concepts* of the power of reason are dawning in force upon scientists; and it is not remarkable that a biographer of Albert Einstein writes: "And right now it is a question whether scientific man is in touch with reality at all—or can ever hope to be."<sup>4</sup>

Nor is it remarkable that Reason's most apt followers are calling for help from Imagination, the faculty of mind which centuries ago Reason attempted to strangle as the mother of superstition. These practical people now say that our failure to evolve new *concepts* is due to the following.

"Belief that indulging in fantasy is a waste of time (yet unusual solutions to problems are often produced through fantasy).

"Too much faith in reason or logic. (The best solutions are not always arrived at through logic.)"<sup>5</sup>

### Aren't All Concepts Already Formulated?

But even if we stay a little afraid of the full power of

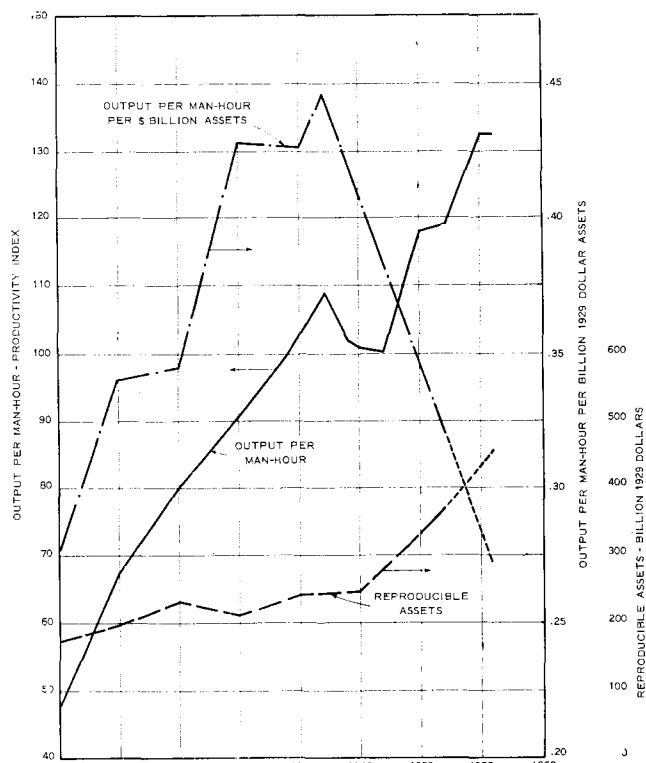


Fig. 3—U. S. manufacturing productivity and total reproducible assets.

*concepts* and if we do harness Imagination to help upstart Reason, is it not possible that we have run completely out of things to discover? In some areas aren't all possible *concepts* formulated?

Perhaps the best way of answering this is to look at an incident relating to the Newtonian concept of the universe which reigned unchallenged for over two centuries. The incident supports energetically the thesis that even the most universally accepted *concept* should be challenged imaginatively to produce new *concepts* and demonstrates at the same time the almost infinite leverage *power* of a certain *concept* most of us never heard of until today.

In 1952, F. S. C. Northrop, Sterling professor of philosophy and law at Yale, wrote: "Einstein once told me that it was his reading of David Hume that made him aware that he did not have to account for the experimental facts of mechanics by Newton's *concepts* and laws . . ."<sup>6</sup>

David Hume died in 1776, the year the U. S. declared independence from Great Britain. Yet his *concept* of human understanding was as powerful about 1900 in casting doubt in Einstein's mind of the existence of a force Newton called "gravity" as it might have been in the hands of an alert thinker observing the primitive frog priests' croaking to bring rain. And the leverage *power* of this *concept* is stupendous in terms of the effects of Einstein's new *concept* upon the world and its inhabitants. Yet scientists like P. W. Bridgman and Erwin Schrodinger believe that the Einsteinian *concept* is still far from perfect.<sup>5</sup>

The question was, if you remember, "In some areas aren't all possible *concepts* formulated?"

If this 200-year-old *concept* of gravity could be jostled from its position as absolute truth merely by the words of a musty philosopher dead over a hundred years, does it not appear that some of the basic tenets of oilfield technology might be subject to radical improvements? The concept of drilling wells by forcing water into a drilling tool under pressure is only a little more than a hundred years old.

### How are New Concepts Formed?

Henri Poincare, one of the modern masters of new *concepts*, tells about how new *concepts* are formed.<sup>9</sup>

A new *concept*, says Poincare, is revealed to us through "unsuspected kinship between other facts, long known, but wrongly believed to be strangers to one another". He says that, of *concepts* possible, "the most fertile will often be those formed of elements drawn from domains which are far apart". Is it possible for us to imagine elements drawn from domains farther apart than today's mathematics of Einstein and yesterday's empirical philosophy of David Hume?

So, perhaps the first prerequisite of new *concepts* in petroleum technology is a widening of interests and understanding in fields other than petroleum technology. Perhaps it may make little difference into what areas such interests and understanding fall as Einstein's interest in and understanding of a seldom-read philosophical work appear to have resulted in one of the greatest conceptual innovations of history. In most of us there are interests—in music, history, literature, art—long thrust aside as unworthy of the time and concern of an engineer dedicated only to the study of useful things. Perhaps these would be more rewarding than we suspect if we picked them up again.

Poincare speaks of invention as being a choice of elements as "of a purchaser before whom are displayed a large number of samples, and who examines them, one after the other, to make a choice. Here the samples would be so numerous that a whole lifetime would not suffice to

examine them. This is not the actual state of things. The sterile combinations do not even present themselves to the mind of the inventor."

But, to Poincare, this does not mean that the searcher for a new *concept* has nothing to do. He tells of one of his great discoveries which began as a series of struggles lasting 15 days with slight success. "One evening," he writes, "contrary to my custom, I drank black coffee and could not sleep. Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination." The next morning he was able to write down the first stage of the new mathematical *concept*. Then he put his work from him and went on a geologic excursion requiring travel and new interests. Yet on this trip, he relates, just as he put his foot one day on the omnibus step, another stage of the new *concept* came to him "without anything in my former thoughts seeming to have paved the way for it . . ." Later he left for military service (a fact significant for us today) and "one day, going along the street, the solution of the difficulty which had stopped me suddenly appeared to me . . . I wrote out my final memoir at a single stroke and without difficulty."

Commenting more generally about the evolution of the new *concept*, Poincare says: "Most striking at first is this appearance of sudden illumination, a manifest sign of long, unconscious prior work . . . Often when one works at a hard question, nothing good is accomplished at the first attack. Then one takes a rest, longer or shorter, and sits down anew to work . . . then all of a sudden the decisive idea presents itself . . . this rest has been filled out with unconscious work and the result of this work has afterward revealed itself . . . There is another remark to be made about the conditions of this unconscious work; it is possible, and of a certainty it is only fruitful, if it is on the one hand preceded and on the other hand followed by a period of conscious work."

This great innovator points out that the process of evolving new *concepts* is not a mere rapid calculator: "It never happens that the unconscious work gives us the result of a somewhat long calculation, *all made*, where we have only to apply fixed rules . . . In the subliminal self, on the contrary, reigns what I should call liberty, if we might give this name to the simple absence of discipline and to the disorder born of chance. Only, this disorder itself permits unexpected combinations."

With further significance, Poincare speaks of the high emotional satisfaction evoked by such successful exercises of the mind—which might have been thought to interest only the intellect. He sees the valid new *concepts* as being only the harmonious—those which are at once useful and beautiful.

### Conclusions

This is perhaps the most important point to remember in connection with yoking curiosity, imagination and reason together in our search for new *concepts*. They must not be useful *only*. They must evoke a high degree of esthetic feeling in the innovator, similar to that accruing to the writer of a poem or to the painter of a beautiful picture. History bears this out for it shows a limit to material progress when progress itself is the only objective—just as it seems to show that there is no limit in sight to what we can achieve if we forget progress as an objective and seek new *concepts* simply because their pursuit and capture again give us the high feeling of unique personality we experienced a few years ago as Ivanhoe, the disinherited knight, rescuing the fair Rowena; as Deerslayer, the frontier's master marksman; as Tom Sawyer and Huck Finn, adventurers without fear, successful boy navigators of the

treacherous Mississippi; as Tom Swift, the boy with a hundred astonishing inventions; or as Tarzan, the unique human king of the apes.

Only in such an individualistic feeling of having done something no one else could possibly have done will an engineer ever climb to the thinly populated heights where live few kings, few rich men and few corporation presidents.

To erect such peaks of individual originality and to give mere men a "vision of the whole" to clamber atop them: that then is the greatest power of concept.

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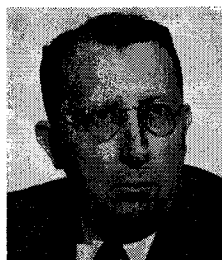
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### Sources for Illustrations

- Fig. 1. Sorokin, P. A.: *Social and Cultural Dynamics*, American Book Co., New York (1937) 2, 150, 179.

- Fig. 2. (a) Calculated from *Statistical Abstract of the United States, 1955*, U. S. Bureau of the Census (1955) 186, 286, 308.  
 (b) Blizard, J. L. B.: "The Future of Discovery and Invention", *The Technology Review* (June, 1954) 395.  
 (c) "The New World of Research, a Special Report to Business Week Readers", *Business Week* (May 28, 1955) 1.  
 (d) *Historical Statistics of the United States, 1789-1945*, U. S. Bureau of the Census (1949) 312.  
 (e) *Statistical Abstract of the United States, 1955*, U. S. Bureau of the Census (1955) 505.  
 (f) Sorokin, P. A.: *Social and Cultural Dynamics*, American Book Co., New York (1937) 2, 179.

- Fig. 3. (a) *Historical Statistics of the United States, 1789-1945*, U. S. Bureau of the Census (1949) 71.  
 (b) *Statistical Abstract of the United States, 1955*, U. S. Bureau of the Census (1955) 309 (Total Assets minus residential).  
 (c) "What Is Happening To Industrial Productivity", *Mill and Factory* (March, 1957) 83. ★★★



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