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of standard one half inch pipe, seven six-inch lengths of standard one fourth inch pipe, and seven one-half inch to one-fourth inch pipe reducers are assembled so that the one half inch pipe is adjacent to a one fourth inch pipe. When these have been assembled into one length of pipe, a one-sixteenth inch hole is drilled in the center of each six inch length of pipe.

The whole assembly may be placed on a lecture table and ordinary illuminating gas passed into one end. The small opening in the pipe will allow enough gas to escape so that small jets of flame will appear at each opening. The jets of flame coming from the one half inch diameter pipes will be higher than those coming from the one-fourth inch diameter pipes, thus illustrating Bernoulli's Principle.

Also, the effect of friction on the gas pressure is demonstrated, since the jets of flame near the open end are not as high as those near the opposite end where the gas enters. When the open end is partially blocked the flames at each opening will be higher thus indicating greater back pressure.

This report is to show that a device to illustrate Bernoulli's Principle may be easily constructed with simple equipment.

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# SCIENTIFIC APPROACH TO REALITY

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There is a fable of several blind men who came upon an elephant. None of them had previous knowledge of or experience with an elephant, and each one examining the animal, came in contact with a different part of its body. The first man touched the elephant's tail and decided the elephant was rope-like. The second blind individual came in contact with its side, and decided the elephant was wall-like. To the third man who contacted the leg, the elephant was stump-like; whereas to the fourth who touched the trunk, the object was a snake-like reality.

In its approach to reality, mankind is often like the blind men and the elephant. We have limited ideas based upon limited knowledge and experience. Yet, we are in the habit of projecting our limited concepts upon the universe and then in identifying these premature concepts as the final answers to the universe itself. We do not distinguish between our concepts of reality and reality itself. Our ideas become final and absolute instead of merely the best approximation of reality under circumstances of limited senses, limited knowledge, limited tools, limited experience. We constantly form concepts based upon that part of the elephant with which we happen to be in contact through our particular religious, racial or national groupings. If we are unwise, we call our own particular incomplete picture the final reality; we call the tail, the elephant, and the elephant a rope. The danger of pre-mature absolutes

is that we shut ourselves off from possibilities of additional knowledge, more complete pictures and a closer approach to reality itself. Worse than that we perpetuate religious, racial and national walls, and we set ourselves in motion against each other.

Even science has been caught in this entanglement. We will not mention the many instances in which, even outstanding men of science in problems outside of their own field, too often show a disappointing lack of open-minded, systematic and critical approach. Rather, we will refer to illustrations in the area of science itself. At the close of the last century a group of prominent scientists meeting at an Eastern university resolved that the physical sciences had attained full scope in Newtonian mechanics. That is, Newton's Laws of Motion and of Gravitation fully covered a universe in which an absolute space provided a fixed framework. A second was always a second; a mile was always a mile. All that was claimed necessary was more and more precision, not structure or scope.

Then, like a bombshell, in 1905, came Einstein's Special Theory of Relativity revealing that Newtonian mechanics was only part of a larger picture in which space, time and simultaneity of events were not absolute and fixed, but relative to the observer; that meter sticks shrunk and clocks slowed down when the motion of the system on which they were located increased and that the mass or quantity of matter of any object increased as its velocity increased. The props of the formerly firm mechanics were shaken, holding only under limited conditions. Science was embarrassed; science was caught short. Why? Science like other areas of human experience had not sufficiently differentiated between concepts of reality and reality itself. Science had projected its concepts of an absolute time and an absolute space upon the universe, and had then identified its own concepts as realities or properties of the universe itself.

How then is science, or how is man, to bridge the gap between his concepts and reality? The first step is to recognize that the difference exists, to recognize that on one hand is man with his senses, physical tools, mental tools, feelings and imagination and the ideas based upon them; and on the other hand, existing independently of man, is the universe.

The second step toward a mature, scientific approach to reality is recognition that our senses, our tools, our experiences, our knowledge and consequently our concepts are of a limited, a selective, a relative character. First, we are limited to the particular receiving mechanisms of the sensory and mental apparatus that we possess. Reality and the universe are sending out their signals in many ways, some known and some unknown to us. Waves are one example. We catch only those messages or waves for which we have receiving mechanisms. For example, by virtue of our eyes and an accompanying nervous system, we receive waves in a range of from about 3500-7000 angstroms to give us light, sight and color. The range of frequencies involved here is a very narrow one in an extremely broad band of electromagnetic waves also including ultraviolet, X-rays, gamma rays, infra-red and even radio waves. Yet, to

see anything beyond red light, on one side, or violet on the other, our eyes are not sensitive enough instruments, just as we are not aware of sound waves below or above a certain pitch or frequency. Yet these waves exist. Another example is the bat, which unlike the human being, has a receiving mechanism that even in pitch darkness makes it aware that it is approaching an object ahead, in a fashion somewhat similar to radar. Japanese experts in earthquake phenomena have reported a sensitivity of animals to earthquake waves that human beings would ordinarily be unaware of except through instruments. Radio waves constantly pass by us everywhere; we are aware of them only when we set up the proper receiving mechanisms. It is true that man has extended his senses through tools that he has devised, such as radio or seismographs, but the number and diversity of the tools as receiving mechanisms are as yet small. There should be many more to come. Those that we now have, in general, can become much more precise. They now involve and they select only the particular types of messages and of knowledge that are known and for which they are designed. Meanwhile, as previously emphasized, we form concepts based upon such limited and partial knowledge, concepts that only begin to approach the whole picture of reality.

Further, if on the one hand, the nature of our knowledge depends on the nature of the senses and the tools that we have, on the other hand, the nature of our tools depends on accumulated past knowledge in a selective process. A great deal of data on atoms and atomic power have been obtained through cyclotrons, betatrons or synchrotons. However, these powerful tools of artificial radioactivity have been possible only because previous discovery and knowledge of radium and other naturally radioactive substances made possible their development. Tremendous devices for artificial radioactivity were a follow-through on natural radioactivity.

Granted the recognition of the incomplete and selective character of our factual knowledge, and therefore of our ideas or concepts of reality, we are still left with the problem of reconciling our ideas of reality with reality itself. How can we keep our ideas in line with reality as we attempt to approach it? How can we minimize being embarrased by reality as we try to form ideas about it? "Operationalism" and "frames of reference" are terms that have risen in answer to this question. Operationalism as first emphasized by P. W. Bridgeman contends that concepts or ideas, e.g. space, time, democracy, should be defined and qualified functionally in terms of the evidence behind the concept. Since evidence genrally arises through observation, tools, processes, and practices of one kind or another, these must enter into the definition of an idea. That is, the definition of an idea should be a working definition. For example a calorie is operationally defined as that amount of heat that will raise the temperature of one gram of water from 15 to 16 degrees centigrade. Or, a year, as time, is understandable in terms of one revolution of the earth around the sun. Concepts thus become defined in terms of actual processes that occur rather than as absolute fixed properties imposed upon things. Light becomes understandable in terms of waves when associated with diffraction gratings; or as corpuscles or photons when photo-electric

cells are used. Perhaps waves and photons will be seen as different aspects of the same thing or as parts of a larger picture when more knowledge becomes available. Meanwhile, as Bridgeman states, "if experience is defined in terms of commonly shared and commonly verified experience there will always be correspondence between experience and our descriptions of it." Meanwhile, prematurely set *a-priori* principles need not exist to limit possibilities of the new experiences and new knowledge that may give the larger picture.

Lastly for a mature scientific approach to reality we might mention, thanks to Einstein, frames of reference in a broad sense as those aspects of the relativity of knowledge due to the particular background or system of motion in which an individual observer is located. If a year of time is determined by a complete revolution of the planet on which the observer happens to be, then a year to an observer on Mars would not be the same as to an observer on the Earth: Mars is hardly halfway around its orbit when the Earth is all the way around its own. Or again, if "up" is the direction away from the center of the earth, then because the earth is spherical, to the observer in the United States "up" is in almost the opposite direction in space than to the observer in China. It all depends on where the observer happens to be.

Implications of operationalism and frames of reference might well provide a fruitful basis for consideration not only in the physical and biological sciences but in the psychological and social sciences as well. The least that we hope such concepts might do, we repeat, is help tear down the walls of absolutes that separate religious, racial and national groups from each other, and that keep them in motion against each other.